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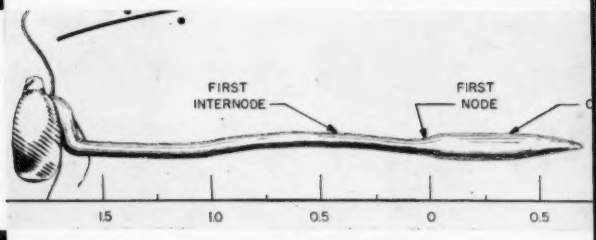

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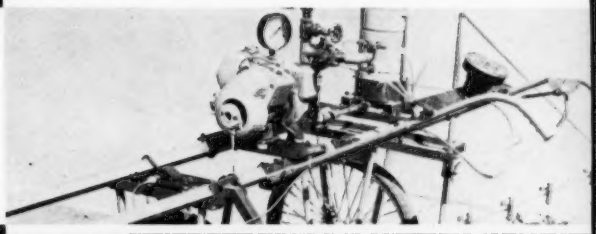

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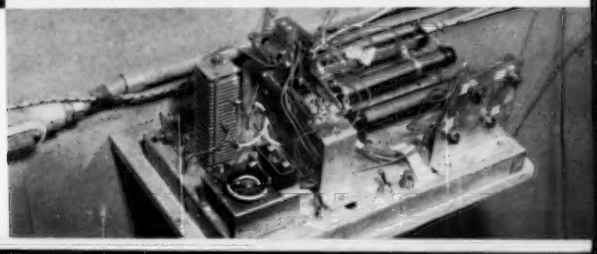
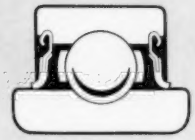
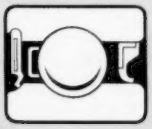


PRODUCT INFORMATION



NEW LAND-RIDING SEAL (Crimped)

N/D's newest seal design. Efficient single lip, low-torque seal protects against moist or dry contaminants. Retains bearing lubricant-for-life. Recommended for farm implement discs, idler pulleys, wheels and similar applications. Available also with metal trash guards to protect seal against mechanical damage from trash windings.

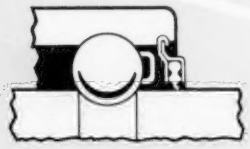


NEW LAND-RIDING SEAL (Pressed) and SENTRI-SEAL

This exclusive seal combination is available in N/D's new heavy-duty conveyor ball bearings. Land-Riding seals, especially resistant to moist contaminant penetration, are available separately in N/D's bearings for hay rake tine bar, plow, hiller and coulter applications. Tandem seal arrangements are also available.

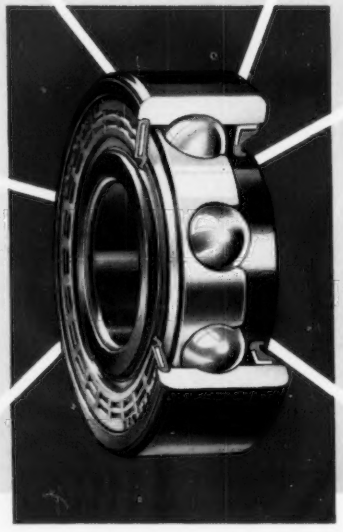
NEW SENTRI-SEAL

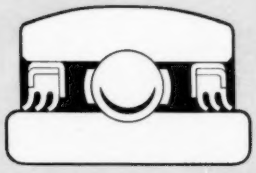
N/D's most versatile seal . . . available in most single row, non-loading groove and small double row N/D ball bearings. N/D Sentri-Seals are recommended for applications with moderate to severe contaminant conditions as found in light duty discs, idler pulleys, cam followers, implement wheels, adapter bearings and similar applications.



NEW DOUBLE "O" SEAL

N/D's most original seal design, used in fan and water pump bearings where water seepage is prime source of bearing contamination. Synthetic rubber seal rides smooth shaft O.D., offers reliable low-torque sealing and eliminates relubrication.





NEW TRIPLE LIP SEAL

N/D's most rugged seal . . . used where moist and dry contaminant conditions are most severe. Seal eliminates relubrication maintenance. It's available in N/D square and round bore ball bearings with either spherical or cylindrical O.D.'s.

N/D Introduces 5 New Integral Ball Bearing Seals!

Now, New Departure offers a versatile line of new integral seals for its farm implement ball bearings. Each N/D seal is engineered to retain bearing lubricant for life . . . and offer maintenance-free service, season after season. These seals are designed to give implement manufacturers a broad selection to choose from for a specific application.

These modern design N/D seals are made of synthetic rubber with supporting steel components for precise control of sealing lip flexibility and torque. Whatever the application, you'll find an N/D integral seal and ball bearing to fit it. All seals are available in popular sizes of New Departure farm implement ball bearings.

Write today for N/D's Integral Seal Bulletin. For detailed information, contact the N/D Sales Engineer in your area. New Departure Division, General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE

BALL BEARINGS

proved reliability you can build around

Tell him how to cut milk production costs

As you know, the housing of dairy cows is a major expense in milk production. Naturally, farmers are quite interested in cutting this expense. U.S. Steel, in cooperation with the University of Wisconsin, studied the problem in *The Dairy Barn Research Project.* The findings were reported to farmers across the country and after a trial period here is what they are finding: a loose housing system makes the most economical and efficient type of dairy operation. Milk production cost per cow goes way down because loose housing saves time, labor costs and capital investment. And the herds stay a lot healthier, too, because a loose housing system is much easier to keep clean.

It's a good idea to have farmers visit operating loose housing systems *before* they decide to switch to loose housing. This will give them a look at how it works and what they'll need to make it successful.

For complete information, have farmers send for U.S. Steel's free book, *Loose Housing.* United States Steel, Agricultural Extension, 525 William Penn Place, Pittsburgh 30, Pennsylvania. *USS is a registered trademark*

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United States Steel USS

Agricultural Engineering

Established 1920

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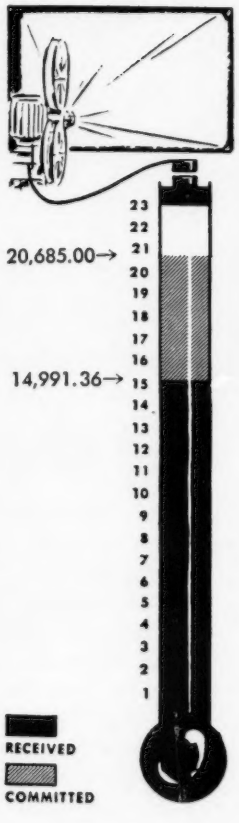
Enthusiastic Response to Motion Picture

COMMENTS and reactions following the premiere showing of the ASAE career motion picture were highly favorable – in fact, enthusiastic! "Agricultural Engineering – Profession with a Future" (that's the title finally agreed upon) is now a reality and around 120 prints are being distributed as planned. All ASAE members are urged to support local sections and agricultural engineering departments in publicizing the availability of this excellent career presentation and in seeing that each print is kept busy at all times.

The picture is indeed a tribute to individual agricultural engineers who contributed personally toward making it possible, to the departments that helped assure production by agreeing to purchase a print even before film content was known, and to our industry friends who demonstrated their support of agricultural engineering by contributing substantially to the cost of production. Industry cooperators will be acknowledged on a leaflet which has been prepared for distribution to those viewing the film.

Financial Status

The "progressometer" tells the story. Industry contributions are coming in at a good rate, but the quota has not yet been realized. The extent to which ASAE can provide the necessary supplemental materials to support the motion picture will depend upon continued good response – (1) from sections whose quota has not been met (only 6), (2) from individuals who have not made a contribution, and (3) from industries who lean heavily on agricultural engineering but have not demonstrated their support.

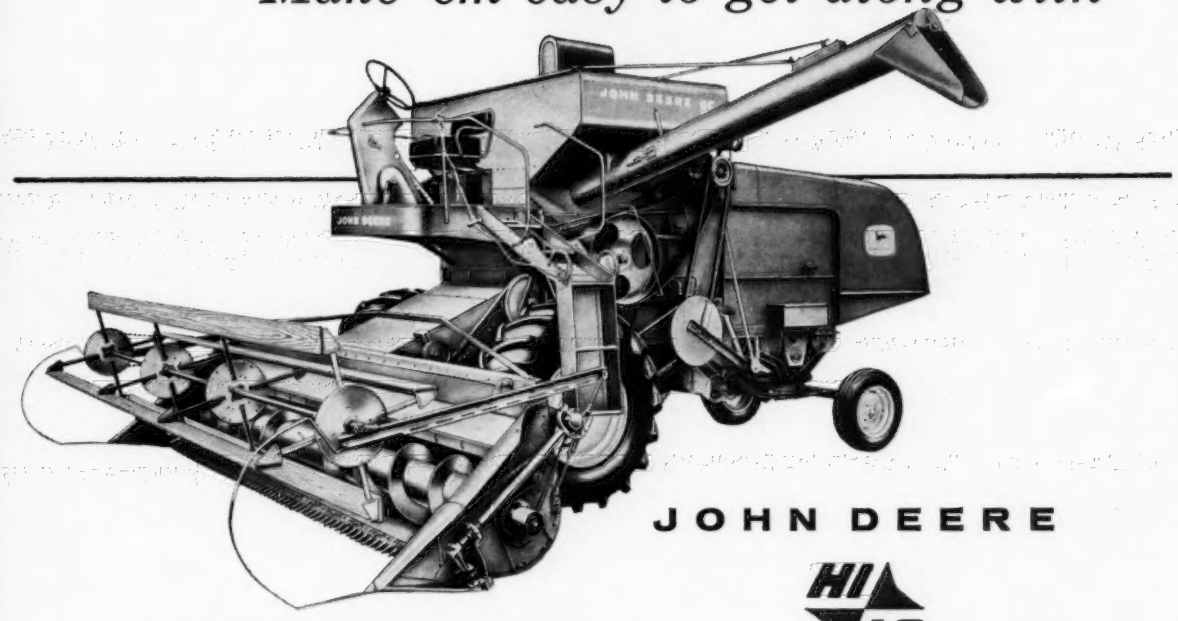


A Five-Step Plan of Action

To help promote the picture and to follow up each showing with supplemental materials, a Five-Step Plan has been advanced. Details are in the hands of ASAE section leaders and agricultural engineering department heads. Supplemental materials include flyers, leaflets, news releases, posters, booklets, instruction sheets, and request cards (see pictures of Five-Step Plan on page 464). Members should check with section leaders or department heads in order that local promotional efforts may be properly coordinated. Let us make full use of this new tool in promoting our profession!

THE FIRST PROBLEM...

Make 'em easy to get along with



JOHN DEERE

HI LO

COMBINES

The first consideration in building John Deere Combines is to make them easy for the operator to do good work—to make them easy to maintain—in short, to make them easy to get along with. The best testimonial that this aim has been achieved, is the fact that literally thousands of farmers have never bought another make of combine after using a John Deere.

You can see why a John Deere Combine is easy to get along with. The very basic design of these machines is conducive to easier operation. The over-all height is low enough to make storage and transport easy. The operator's platform is up high, out of dust and flying chaff. It is centered above the cutter bar for good visibility of the crop as it is being cut or picked up. The grain tank and engine are *in line* on top of the combine with weight centered between the drive wheels. There's always good weight distribution even when the grain tank is full.

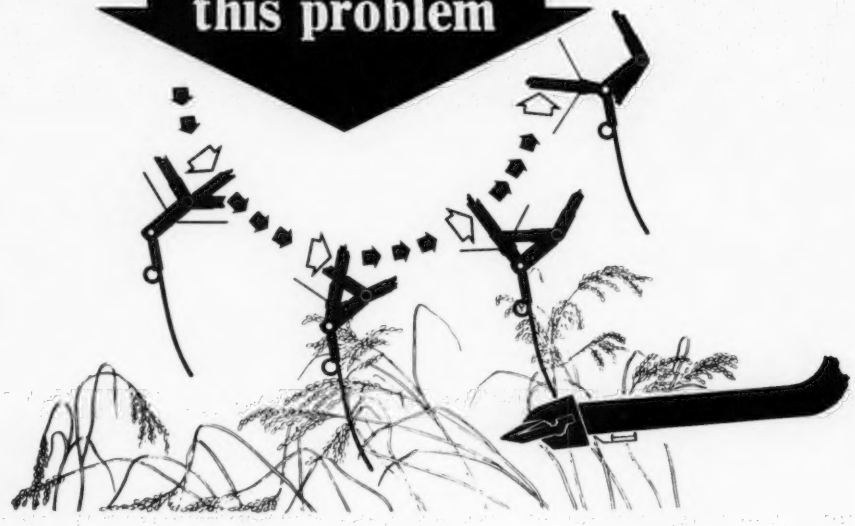
Less conspicuous but equally important is the convenient grouping of controls. The operator has complete command of the combine at his finger tips. All controls can be reached, and all gauges easily read from a sitting or standing position.

All adjustments on John Deere Combines can be made from the outside of the machine. The operator can see what he is doing. All lubrication points are easily reached—and they have been held to a bare minimum. Most operators say they can get ready for the field in less than 10 minutes.

Any machine with the tremendous number of working parts that go to make up a combine is apt to have a measure of bother in its use. By that, we mean small breakages are apt to occur under long or heavy use. But, owners of John Deere Combines know, and are quick to tell you, that there is less "bother" in using a John Deere Combine—that they are truly easy to get along with.

JOHN DEERE • 3300 RIVER DRIVE • MOLINE, ILLINOIS

let us help you solve this problem



A pick-up type reel is an important contribution to the performance of any harvester — and the design of the right harvester-matched reel is a specialized problem. Why not employ our engineering skill and background to help in this important phase of your overall harvester design? Drawing on our experience of over 25 years and many exclusive patents, we can engineer a pick-up reel tailored to the other design characteristics of your machine, and the crops and areas being served. As a leading producer of pick-up reels, we have the plant capacity and automated production lines to assure you of delivery at reasonable costs. Let us conserve your valuable engineering time.

Also designers and manufacturers of harvesting machines for green peas, spinach, lima beans, mint, greens, pumpkins and other specialized crops.

H. D. HUME COMPANY
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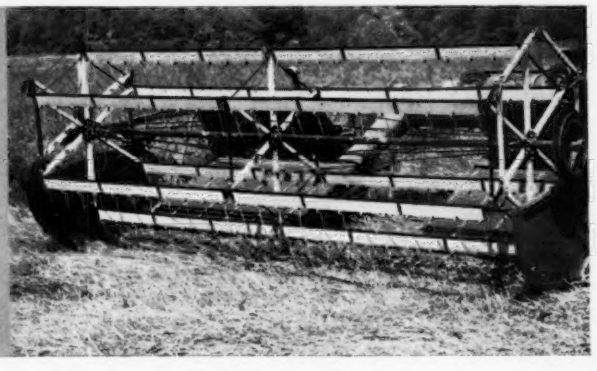

Solving difficult Bearing and Special Parts Problems–

an Aetna Specialty

The challenge of new and unusual problems is of continuous interest to Aetna design and application engineers. Their readiness to accept the difficult has established Aetna as a leading source for specially engineered or hard-to-make bearings, and hardened and ground precision parts.

Whatever your problems may be, the Aetna engineering facilities for design and application are available to assist you. Why not outline your anti-friction or parts problems for Aetna study, consideration, and recommendations on how to best achieve operational efficiency and long life expectancy in your products.

Aetna

AETNA BALL and ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION

4600 SCHUBERT AVE.
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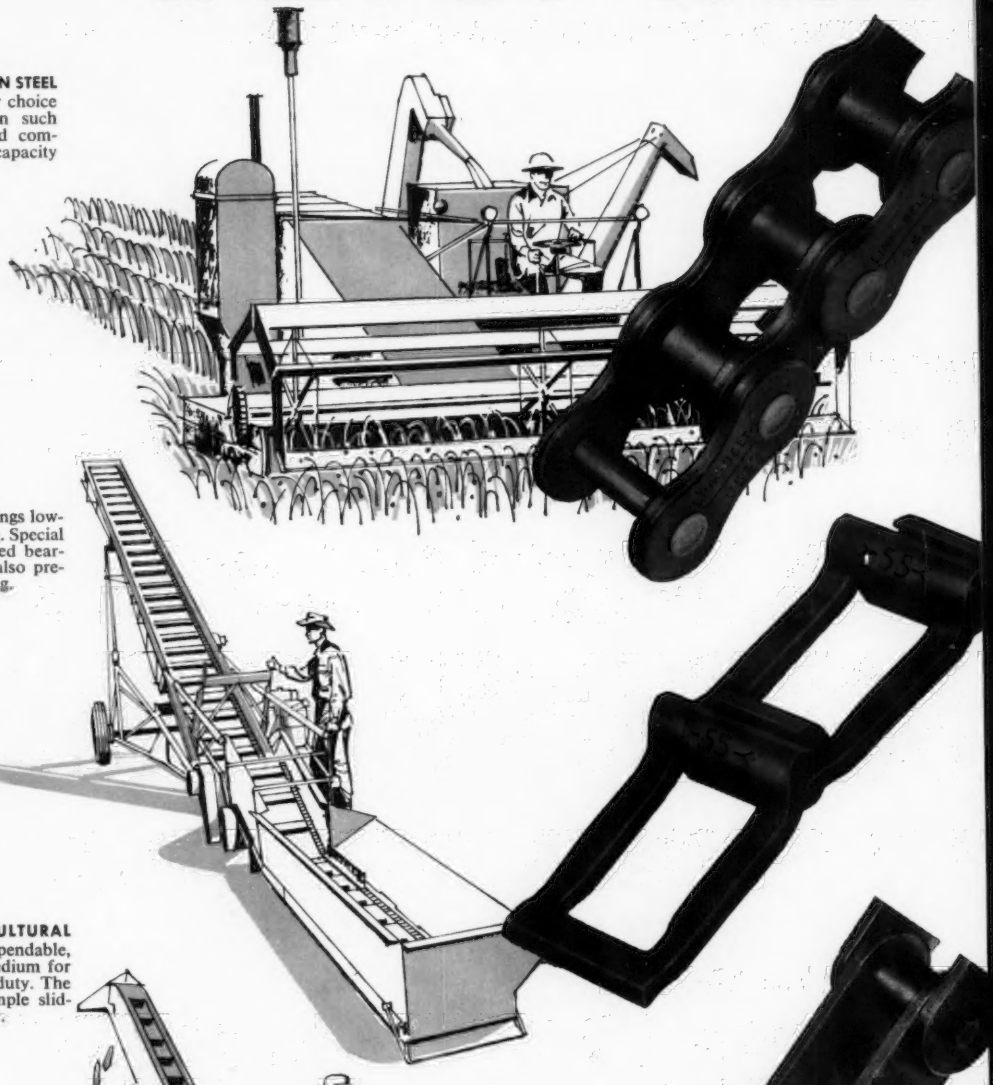
ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

LINK-BELT DRIVE AND CONVEYOR CHAINS

travel with



STANDARD-PITCH PRECISION STEEL ROLLER CHAIN is a popular choice for transmitting power on such equipment as self-propelled combines. It features high hp capacity and light weight.

STEEL LINK-BELT CHAIN brings low-cost efficiency to conveying. Special hook design provides added bearing area for added life—also prevents accidental uncoupling.

DOUBLE-PITCH AGRICULTURAL ROLLER CHAIN is a dependable, long-lasting conveying medium for corn picking and similar duty. The straight sidebars have ample sliding surfaces to resist wear.

IMPORTANT!

Link-Belt Roller Chains for the agricultural field are *true* roller chains. They have *free-turning* rollers. Hence, longer life for chain and sprocket because there's no scrubbing or sliding over sprocket teeth.

the leaders

Over 300 quality-conscious farm machine manufacturers rely on Link-Belt for chain . . . and bonus services besides

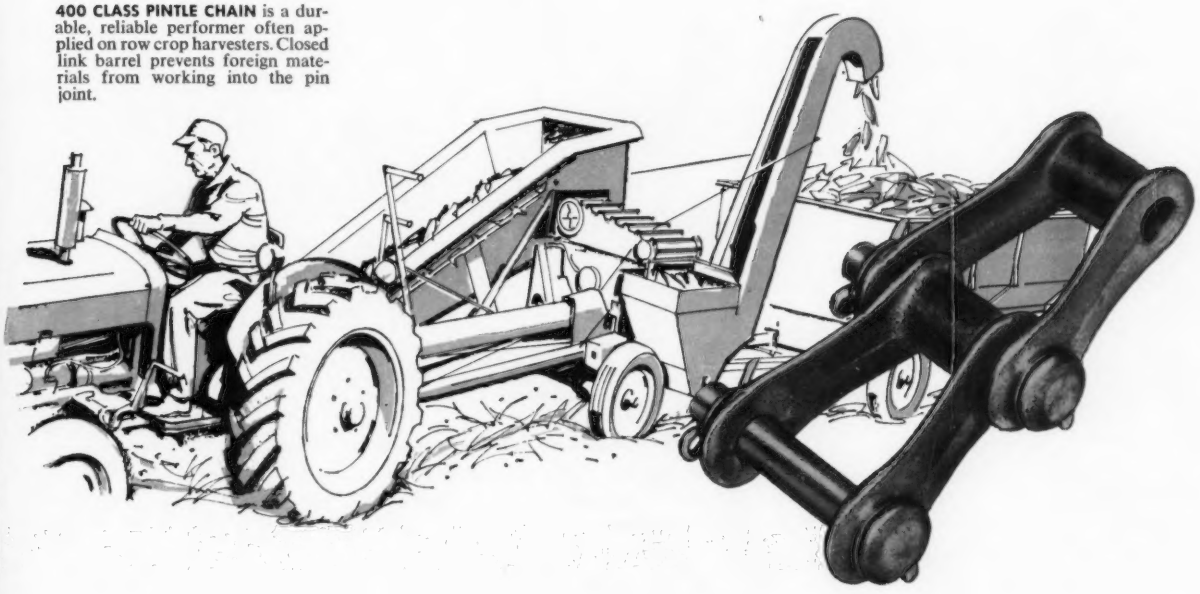
THE finest farm machine can be stopped dead in its tracks by chain failures. That's why so many foremost manufacturers want the best in chain . . . and therefore, choose Link-Belt. The leaders realize that the many refinements built into Link-Belt chain make a vast difference in field performance. And this important consideration, they know, helps assure customer satisfaction for their quality machines.

Link-Belt chains easily withstand the day-in, day-out punishment encountered in the field. They shrug off impact and shock loading . . . provide smooth, positive, all-weather service. There's consistent quality and unvarying pitch uniformity in every link.

Link-Belt offers industry's most complete line of drive chains, conveyor chains, attachments and sprockets. Also, "bonus" services that aid the designer, improve the design: application counsel, field analysis, laboratory service and others. These services multiply the *value* of Link-Belt chains . . . but because they are offered as standard features, *they don't multiply the price!*

On any drive or conveying application, take advantage of Link-Belt's unmatched facilities, experience and services. For details, contact your nearest Link-Belt office. Ask for 640-page Catalog 1050, covering the complete line of Link-Belt conveyor and power transmission products.

400 CLASS PINTLE CHAIN is a durable, reliable performer often applied on row crop harvesters. Closed link barrel prevents foreign materials from working into the pin joint.



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CHAINS AND SPROCKETS

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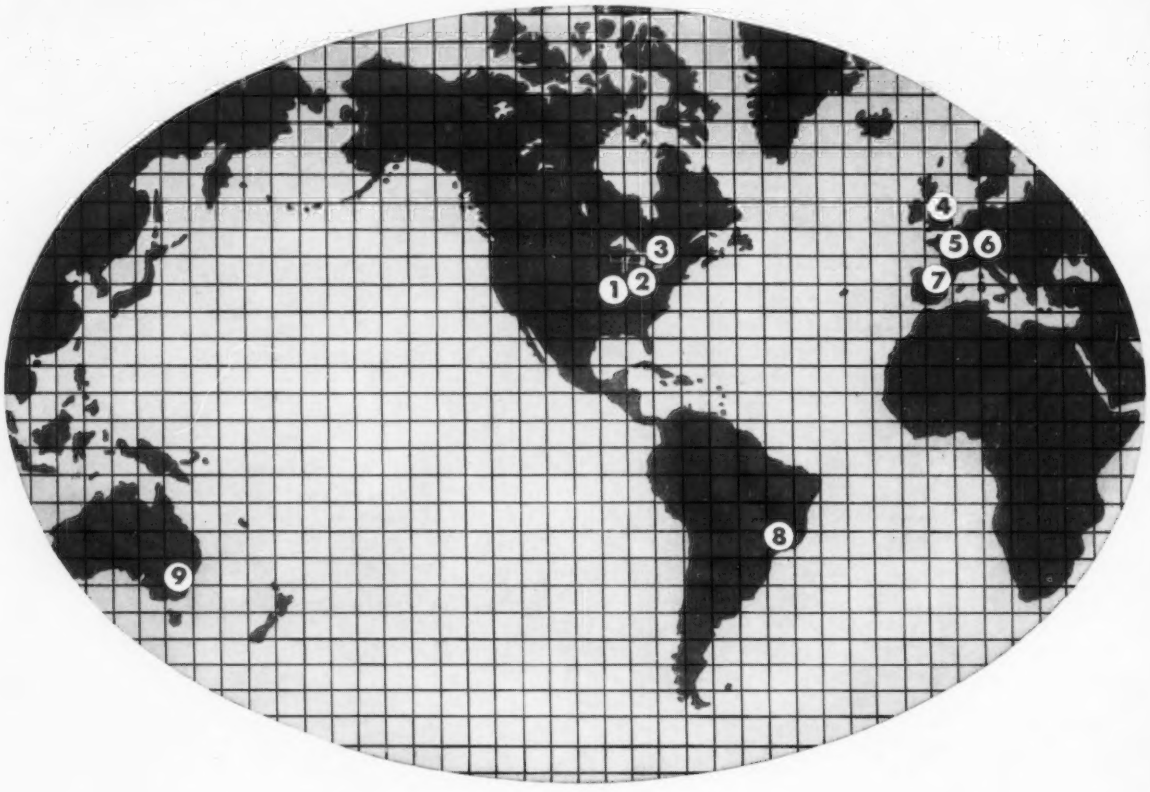

good steering gets around...

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NEW ONE-OF-A-KIND MICROGRAPH

draws pictures for bearing research

This greatly magnified stylus is drawing a picture of the microscopic imperfections in a bearing raceway . . . measuring each one to within a few millionths of an inch. The picture-on-tape which comes out of this specially modified micrological instrument is an important tool in BCA's research on ball bearing performance.

This is just one of the precision instruments in the Temperature-Humidity-Controlled Instrumentation Room which is the center of BCA research on bearings. The result of this program is revealed in on-the-job performance of BCA bearings. They roll dependably under heavy loads and all kinds of adverse conditions.

New testing facilities at the BCA laboratories also include specially designed equipment, often identical with equipment in customers' plants. Here, BCA bearings are tested to exceed customer specifications *under the exact operating conditions experienced by the customer!*

BCA ball bearings are standard original equipment . . . replacement, too . . . for nearly every kind of industry. For example, automotive, earth moving, agricultural and machine tools. The wide line of ball bearing sizes and types, plus BCA's research and extensive new testing facilities, pays off for bearing users. Consider the performance record of BCA ball bearings the next time you purchase or specify bearings. For more information, or for assistance with bearings problems, contact Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

BCA

BEARINGS COMPANY OF AMERICA

ball bearings

DIVISION OF
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BEARINGS, INC.

Report to Readers . . .

"MEAL-SIZE" CUBE, NEWEST FORM OF HAY PACKAGE FOR DAIRY COWS A University of Minnesota agricultural engineer told an ASAE meeting last month about a new idea in hay baling - a light, 12-inch cube, enough for one dairy cow's meal. These 10 to 15-lb bales are easy to handle mechanically and dry artificially, which would be a big help in preserving hay quality. . . . . In the small bale form, hay has almost twice as much exposed area per pound as in the larger conventional bale. Another thing, nearly nine-tenths of the hay in small bales is within 3 inches of the surface, as compared with about two-thirds for conventional bales. As a result, hay in small bales can be dried with duct-type mow driers, with either heated or unheated air, almost as easily as the same amount of chopped hay. . . . . A further advantage of small bales is that they do not have to be stacked or arranged in any particular way when placed in a barn mow equipped for drying. They can simply be dropped and left where they fall. . . . . To make the small bales, the engineers modified a baler originally designed to make conventional bales. No difficulty was experienced in making the small bales, even with alfalfa averaging 35 percent moisture. . . . . Because of their small size, the cubic bales did not buckle. Two pieces of twine per bale were used, but the engineers believe further development will indicate that one tie is sufficient.

NEW CONVEYOR MOVES HAY FROM MOW TO FEED CHUTE A Cornell agricultural engineer has developed a mow conveyor that gives promise of saving much energy and time from farm workers. Replacing the laborious task of moving hay by hand from mow to feed chute, the hay is placed on a moving chain of flights on this new conveyor which slides it to the chute, from whence it is carried down into the animals' feeding troughs below. . . . . The device is said to cut down the time of handling the hay by one-third and it can be used for either chopped or baled hay.

MECHANICAL HARVESTING OF TOMATOES LOOKS PROMISING "The future for the mechanical harvesting of tomatoes looks even more promising than for such crops as beans, peas or pickling cucumbers." So stated a Michigan AES agricultural engineering-horticulture research team at an ASAE meeting. Several changes have been made in their prototype harvester to be field tested again this season. So far, it is stated, no mechanical problem has appeared that cannot be solved. . . . . Studies are continuing on testing of varieties, cultural practices, chemicals for concentrated fruit set, methods for handling fruit after harvest, and development of a planting and harvesting sequence intended to insure a uniform supply of harvested tomatoes at the processing plant. . . . . The incentive for developing a successful tomato harvester, mentioned elsewhere in this issue, lies mainly in the increasing difficulty of procuring hand labor, a major item in an estimated potential saving of 15 million dollars for growers.

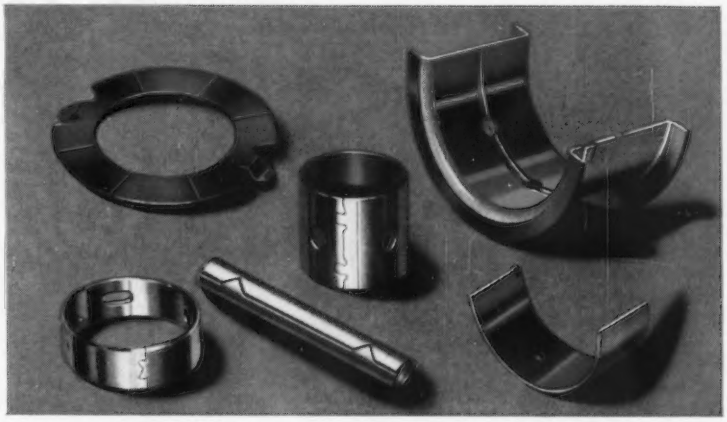
ENGINEERS CAN NOW MEASURE SNOW PACK ELECTRONICALLY The Idaho Engineering Experiment Station is in process of developing compact, automatic, electronic equipment for recording the thousands of snow measurements taken each winter by the U.S. Soil Conservation Service for reporting the potential annual water harvest. It is said that one of the complete units for this purpose, including transistors (in place of vacuum tubes) and storage batteries, would occupy no more space than a suitcase. . . . . By means of such units, the water content of the snow, as well as of the soil under the snow, would be automatically measured electronically. Data for such measurements would always be available for transmission, on query electronically by the central station. Units and batteries can be left in place for the nine months of the snow-survey season and then checked, repaired or replaced during the three summer months.

(Continued on page 420)

75-MILLIONTHS OF AN INCH BARRIER HALTS METAL MIGRATION

JUST BENEATH THE FRESH OVERPLATE OF THESE F-M ENGINE BEARINGS (LEFT) LIES A TENUOUS DIFFUSION BARRIER. Though this film of metal is only 75-millionths of an inch thin, it stops tin in the overplate from migrating into the lining metal beneath. Its presence is important to bearing overplate performance, particularly during the critical period of engine break-in. Maintaining uniform thinness as well as uniform composition of the plated barrier is most important . . . and most difficult to achieve on a production scale. Federal-Mogul research has developed a unique, extraordinarily precise method for controlling both the thinness and the metallic composition of this barrier, within narrow limits. And the performance of F-M engine sleeve bearings attests to the success of the method!

RESEARCH INTO ELECTROPLATING problems is a continuing project in the F-M laboratories. Unusual precision equipment and facilities are employed, many of which have been specially designed and engineered by F-M to solve problems of sliding-bearing application. As a result, Federal-Mogul engineered sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers provide the finest possible performance characteristics for any application.



Have you a problem with bearings, bushings or washers? Are you considering the development or redesign of an item of the type shown above? We'll be glad to show you how the job can be done most effectively and economically. For information, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11081 Shoemaker, Detroit 13, Michigan.

FEDERAL-MOGUL

sleeve bearings
bushings-spacers
thrust washers

DIVISION OF
FEDERAL-MOGUL-BOWER
BEARINGS, INC.

. . . Report to Readers (Continued from page 418)

ELECTROSTATIC SEPARATOR DEVELOPED TO SEPARATE CROP SEEDS FROM WEED SEEDS

A USDA agricultural engineer reports an important new development in seed cleaning - an electrostatic seed separator. This development was made possible by the fact that crop seeds and weed seeds conduct electrical charges at varying rates. . . . . The screening used in many seed separators does a poor job of sorting mixtures of crop and weed seeds because they are almost identical in size and shape. In the electrostatic separator, however, the seeds pass through a high-voltage electrical field and are charged and separated according to their electrical conductivities. . . . . This development is specially significant in light of the fact that some 150 kinds of agricultural seeds are produced annually in the United States with a value of more than $300 million - and this does not include vegetable and flower seeds.

MECHANIZATION RATED A MUST IN HARVESTING AND HANDLING FRUIT

Many industry experts agree, it is said, that those farm crops, the harvesting and handling of which are not mechanized, will not continue to be produced on a commercial scale. The case of fruit crops presents perhaps the most glaring example, requiring as it does each year nearly 900,000 migratory workers. To develop mechanical equipment to greatly reduce this need and otherwise reduce harvesting and handling costs presents the challenge, say USDA agricultural engineers, of some of the most difficult problems in machinery design. . . . . These engineers report success of machines and methods for commercial production of prunes in California, and experimental models are under test for harvesting olives, peaches and apricots in the West and sour cherries, blueberries and plums in Michigan. Cherry-harvesting equipment on trial in Michigan, for example, shakes 95 to 98 percent of the crop into collecting frames, from which conveyors move the fruit to tanks of cold water mounted on pallets.

CHEMICAL CONTROL OF WEEDS AND OF PLANT DISEASES GOES UNDERGROUND

A USDA plant pathologist-agricultural engineer research team told an ASAE meeting last month that chemicals for controlling weeds and plant diseases are more effective when applied underground than when sprayed or spread on the surface and worked into the soil with tillage tools. The researchers reported on tests with fluorescent tracers, now in use for such purposes as crime detection and medicine, to locate accurately the placement of herbicides and fungicides in the soil. . . . . They developed a special device for spraying the chemicals behind a 20-inch-wide blade mounted on a cultivator. It was found in these tests that mixing the chemicals with soil after the subsurface application did not increase their effectiveness.

CHOICE OF CONDITIONER MAKES LITTLE DIFFERENCE IN EFFECT ON HAY DRYING

Given fairly good drying weather, the researchers say the field-drying time for alfalfa hay can be reduced one day by using a hay conditioner directly after mowing. However, University of Minnesota agricultural engineers say the type of hay conditioner chosen makes little difference so far as the effect on drying the hay is concerned. They have recently compared five types of conditioners, one was a crusher with smooth rolls; a second had rolls with tire carcass stamping; a third was a bar-type crimper, and a fourth was a crimper-crusher with one smooth steel roll and another roll with steel bars welded to it in a spiral pattern. The fifth type was a 12-foot swather with 4-foot crimping rolls. . . . . Results from use of all five types of conditioners on first-crop alfalfa-brome and on second cutting of all alfalfa were virtually the same. More important than the type of conditioner, say the engineers, is to have the machine properly adjusted. Such differences as the engineers did find among the different types of conditioners was due mainly to adjustment rather than to design.

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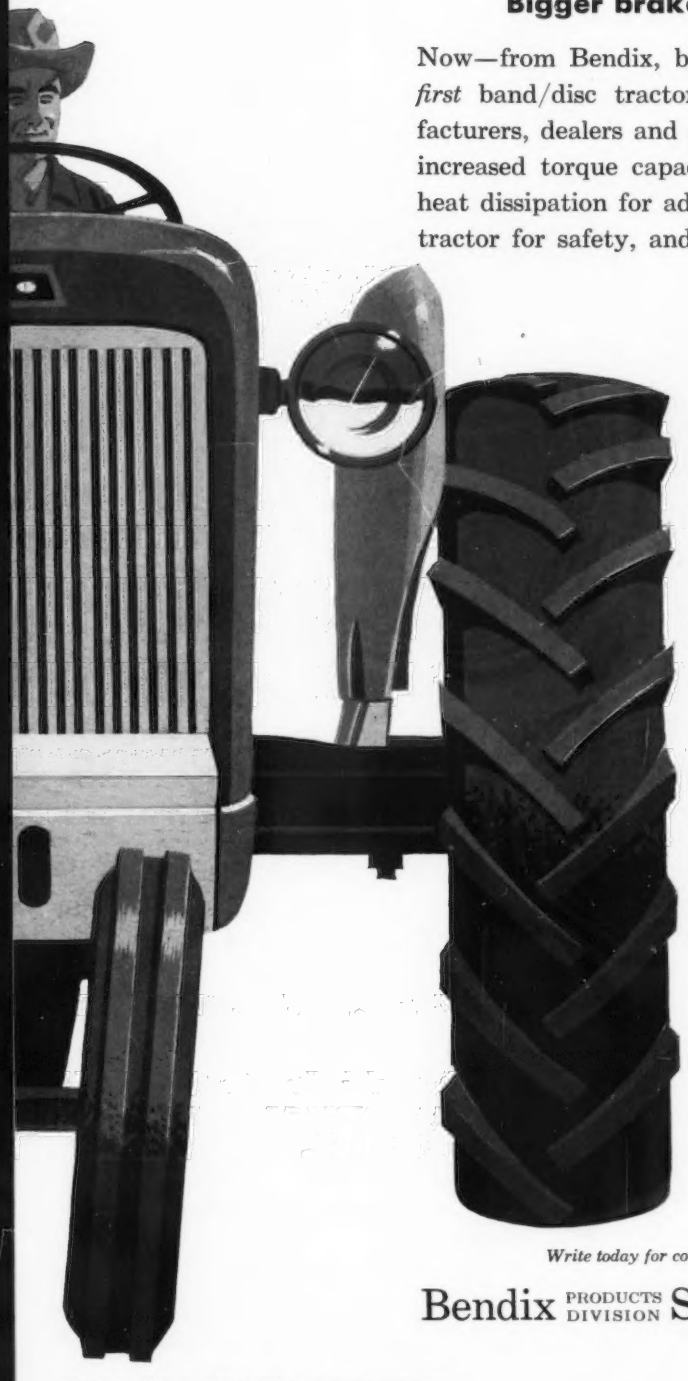

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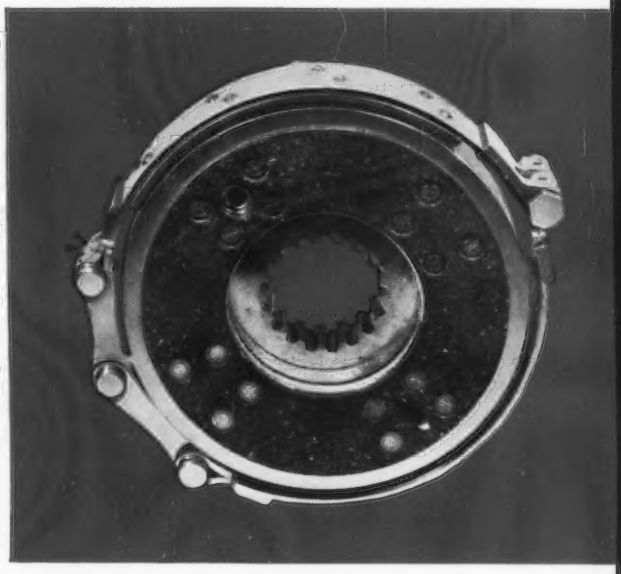

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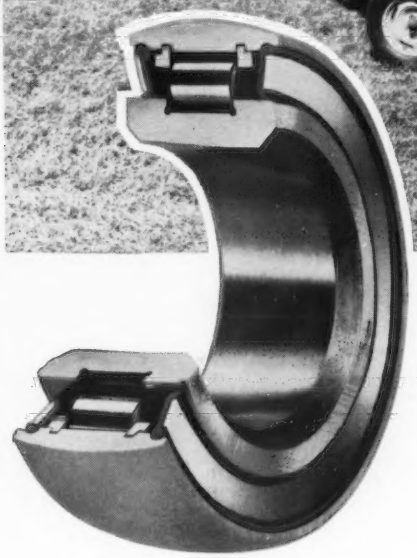

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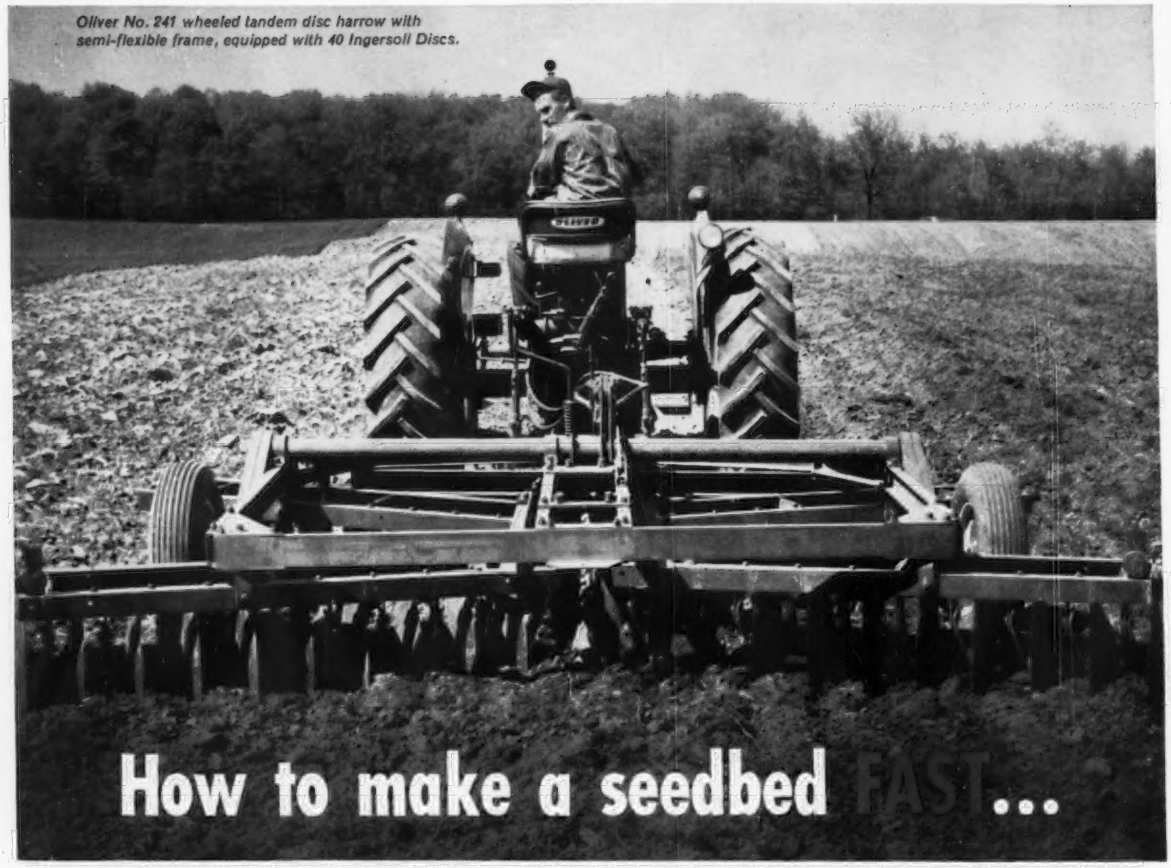

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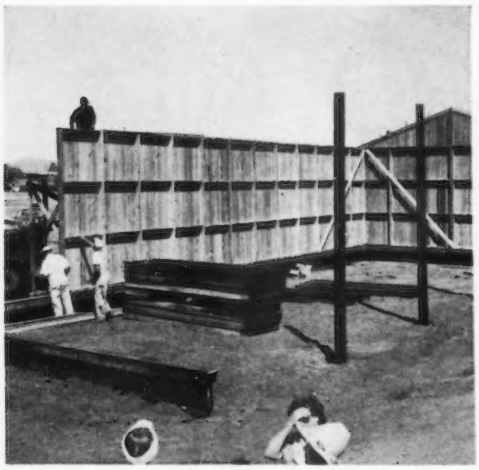

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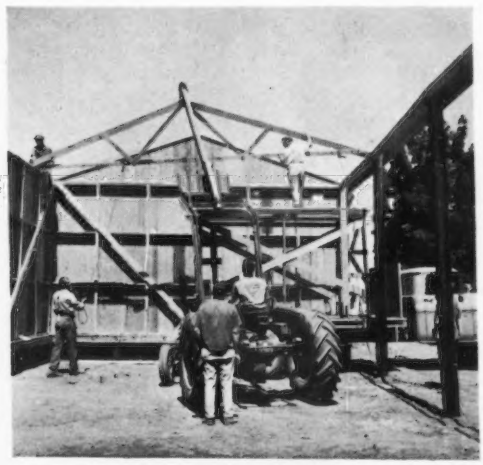

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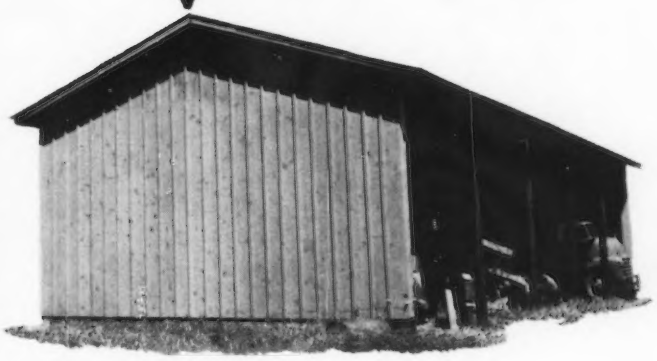

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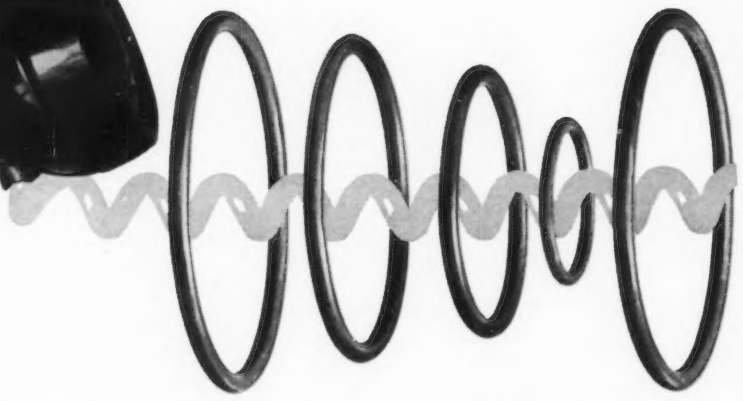

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James Basselman, *Editor*

EXTENDING OUR HORIZONS

ONE of Webster's definitions for horizon is "limit or range of perception or experience." Note that it is not limit of sight alone, but of perception and experience of that which is seen.

As a boy on an Iowa farm, my personal horizons were definitely limited — both my sight and my thoughts and aspirations. The visual horizon there could be expanded by cilmbing to the top of the silo or the windmill tower. My mental horizon was extended by reading, by the new invention of radio, and by contacts with professional agriculturists, educators, and scientists. Among these were the vocational-agriculture instructor, the math and physics teacher, the school superintendent and the county 4-H club leader.

However, on finishing high school, the possibilities for widening personal-experience horizons appeared quite limited for the son of immigrants who had just lost everything in the 1929-30 economic crash. But, by what the professional folks taught me, I managed to win a trip to the National 4-H Congress and was there inspired by several national leaders. Then, in the state fair judging competition, a modest scholarship was won at Iowa State College, where I had the privilege and pleasure of studying under Dr. J. B. Davidson, one of the revered founders of our profession and our society. Needless to add, he and his staff truly extended my horizons.

It may now seem to many of you that the horizons of our profession are likewise limited. We know that the economic status of the industry of agriculture which we serve, and of its farmers, is not good in comparison with other industries or other segments of our population. This was pointed up strongly to me in a letter from G. B. Gunlogson of Racine, Wisconsin, one of our ASAE members who has retired from business, but who is still active in an effort to point out the need for engineering leadership in agriculture.

Mr. Gunlogson stated that "during the last ten years the output per man-hour on the farm has gone up over 60 percent, while the farmer's income from this production has gone down. In fact, his buying power (parity ratio) has gone down about 15 percent in ten years. Yet the cost of the market basket has advanced 10 percent." Mr. Gunlogson further pointed out that agricultural engineers should assume more initiative in providing effective leadership for the entire industry of agriculture, and he is continuing his worth-while efforts as a member of our ASAE Forward Planning Committee.

Lawrence H. Skromme

President, ASAE, 1959-60, and chief engineer, New Holland Machine Co., Division of Sperry Rand Corp.

My own thought is that the farmer needs us — both the service and the leadership of agricultural engineers — even more now than if he were prospering in a flourishing industry. While the situation may make some aspects of our task more difficult, surely it is all the more of a challenge to us for that very reason.

Perhaps our profession will find, as I learned in my youth, that it is easier to get some things done during times of economic stress. For example, the fact that a college education cost very little then, in comparison with the present, has been forcibly brought home to me as I now plan to educate my three daughters.

In endeavoring to extend the horizons of our profession, we must of course recognize that it is imperative that each of us continue to do a good job in our respective fields. The risks of neglecting our present work or of extending ourselves too far are obvious, and we must not risk the certain consequences of such rash action.

However, as we grow, we should and must broaden out into new fields so that we may use our training, skills, and experience in applying scientific knowledge to new problems that will further benefit our farms and farmers. One rather obvious field in which we are now becoming engrossed is that of materials handling on the farm and the related field of farmstead mechanization. This we might well have done long ago since the basic knowledge needed to improve farm materials handling and to mechanize the farmstead has been available for many years. Admittedly, many serious problems are involved including the following:

1 Farmstead mechanization cuts across present divisional lines of our profession. Power, mechanical equipment, structures and electricity (both for power and for control) are all involved.

2 Huge present investments exist in structures and facilities which are permanent and fixed and cannot be readily "traded in" like an automobile, tractor, combine, or hay baler.

3 New merchandising methods need to be worked out to distribute this type of equipment on a mass basis. This leads to sticky questions such as, who does the construction work — the field engineering? Or, can we work out means to show dealers and farmers quickly how to revise structures and install new items without specific, detailed specifications for each installation?

To help make a start in this difficult field, we have enjoyed assistance in the form of goading by another impatient leader, George H. Seferovich, editor of *Implement & Tractor* magazine, who has stimulated this development through critical editorials and excellent feature articles. Developments in the past few months indicate that we are finally making progress in solving these problems for the farmer, in cooperation with the related industries that provide his power, his equipment, and his materials. The Farmstead Engineering Conference to be held next September at Urbana, Ill., which has been planned and organized by some of the forward-thinking leaders of our profession, should help accelerate this vital program.

Another new field which warrants our attention is that of food processing and technology — or food engineering, as it has come to be more properly termed. Dr. Arthur W. Farrall, head of the agricultural engineering department at Michigan State University, has long believed that this field should rightfully be another major division of agricultural engineering. In keeping with this thinking, for the past decade or so Michigan State has offered courses for training agricultural engineers in food processing engineering. A number of these graduates now hold responsible positions in the food-processing industry. Now, a new department in food science has been established at

(Continued on page 456)

Annual address of the President of the American Society of Agricultural Engineers before the 53rd Annual Meeting of the Society at Ohio State University, Columbus, June 12-15, 1960.

Emergence Energy of Plant Seedlings

Seed environment essential for maximum emergence of seedlings

C. T. Morton and W. F. Buchele
Assoc. Member ASAE *Member ASAE*

ALTHOUGH physical properties of soil conducive to plant growth can be recognized by the experienced observer, they have not been defined satisfactorily in mathematical or physical terms. No single value or group of values expresses the optimum conditions for germination and seedling emergence.

At present, the design of precision planters is hampered by lack of adequate basic information concerning ideal environment for rapid emergence of seedlings. Factors such as soil moisture content, seedbed tillage, depth of planting, amount and position of compacting pressure, aeration, and mechanical impedance to emergence must be accurately described in physical terms so they can be translated into a functionally designed unit.

This paper reports a method of measuring force and energy exerted by a mechanical seedling (a steel probe simulating a seedling) as it moves upward through the surface soil under different levels of soil compaction and soil moisture. Basic factors affecting the energy required for emergence of plant seedlings will be presented along with suggestions for reducing the energy.

Review of Literature

The literature survey revealed that the forces exerted by plants on their surroundings was studied by Pfeffer in 1893 as translated by Gill (2)*. He measured the force exerted by various species of plants on soils by encasing the root of a seedling in a plaster of paris block and the shoot in another block. He observed that significant growth occurred with axial counterpressure up to about 10 atm (atmospheres) and with radial counterpressures up to about 6.5 atm. Pfeffer also measured the external work performed by a growing plant; in a 24-hr period at a moisture content of 18.3 percent, the work performed by a corn root was found to be 1290 gm-mm. He reported that, when a root was grown against a resistance, the rate of growth was zero until the cellular tugor pressure increased sufficiently to overcome the resistance. After this point, the growth rate in general was found to be constant and up to a certain point, independent of the magnitude of the external resistance. Pfeffer reported that since the root had plastic properties, the path of growth would generally be along the line of least resistance. This indicated that the pressure exerted by a root would be less than the pressure measured with a penetrometer. High values of axial pressures were encountered when the root was confined in the radial direction.

Gill (3) devised a rubber diaphragm cell that offered mechanical impedance to root growth under controlled soil atmosphere. He reported that the rate of growth fell to zero at small levels of impedance when the oxygen content was low. The first increment of chamber pressure reduced the rate of elongation more than the second increment. The deformed roots were examined microscopically and the cells were found to be flattened. As the applied chamber pressure was increased and oxygen content of soil atmosphere decreased, the root growth decreased.

Hudspeth (6) studied the effect of planting depth on the rate and total emergence of cotton. Although the final emergence was not affected by depth of planting, significantly higher yields were harvested from the 1 to 2-in. planting depths as compared to a 4-in. depth.

Carnes (1) used the modulus of rupture to measure the breaking strength of crust under conditions of wetting and drying. He reported that reducing the rate of drying increased the strength of the crust. An inverse relationship was found between the breaking strength and moisture content of the crust. The chemical nature of the soil affected the breaking strength of the crust. In cotton fields, the modulus of rupture of the soil crust was greater in the middles than on the ridges.

Hanks and Thorp (4, 5) reported that the modulus of rupture is a good measure of crust strength as related to seedling emergence of wheat and similar plants. They found that the limiting crust strength was between 200 and 500 millibars (a unit of pressure—1,000 dynes per square centimeter or 0.0145 psi) for wheat seedling emergence and appeared to decrease as the amount of available moisture decreased. The rate of wheat seedling emergence was directly related to soil moisture content. Bulk density was related indirectly to seedling emergence in that any change in bulk density changed other factors such as oxygen diffusion rate and soil crust strength. Wheat seedling emergence was not influenced by seed spacing or crust thickness for a range of crust strengths as measured by the modulus of rupture. The force required to break a ½-in.-thick soil crust was 1.83 times greater than for a ⅜-in. crust. Their data indicated that the emergence of a wheat seedling through a crust is influenced by the strength of the crust immediately around the growing tip and not by the strength of the entire crust.

Apparatus

An instrument (Fig. 1) was designed, fabricated, and developed for measuring the energy expended during the emergence of a "mechanical seedling" (probe). The mechanical seedling was forced upward through a surface soil formation in a manner similar to an emerging seedling. The instrument consists of a simply supported beam em-

Condensed version of a paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Ithaca, N. Y., June 1959, on a program arranged by the Power and Machinery Division. (NOTE: The original paper was based on an M.S. thesis by the senior author, prepared while attending Michigan State University.) Authorized for publication as Journal Article No. 2603 of the Michigan Agricultural Experiment Station.

The authors — C. T. MORTON and W. F. BUCHELE — are, respectively, research engineer, Tractor and Implement Division, Ford Motor Co., Detroit, Mich., and associate professor, agricultural engineering department, Michigan State University, East Lansing.

*Numbers in parentheses refer to the appended references.

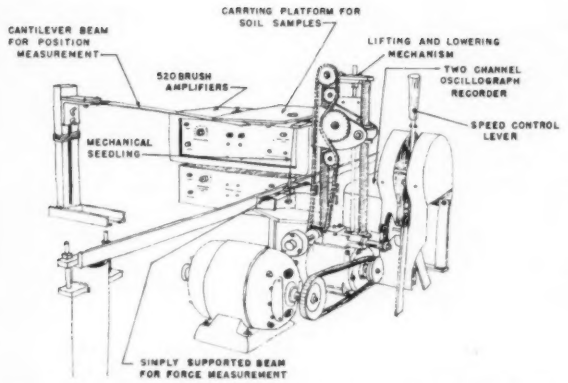
CARRYING PLATFORM FOR SOIL SAMPLES
CANTILEVER BEAM FOR POSITION MEASUREMENT
LIFTING AND LOWERING MECHANISM
520 BRUSH AMPLIFIERS
TWO CHANNEL OSCILLOGRAPH RECORDER
SPEED CONTROL LEVER
MECHANICAL SEEDLING
SIMPLY SUPPORTED BEAM FOR FORCE MEASUREMENT

Fig. 1 Diagram of soil penetrometer used in the research study reported in this paper (Original design by B. A. Stout, agricultural engineering department, Michigan State University)

ploying an SR-4 strain gage bridge for sensing the force being exerted by the mechanical seedling, a holder for which was located in the center of the beam. A cantilever beam with a four-arm strain gage bridge was used to indicate the position of the mechanical seedling tip in the soil. The signals from the strain gage bridges were amplified by two model 520 Brush amplifiers and were recorded on a two-channel oscillograph. This gave a continuous record of force and position as the mechanical seedling was pushed through a 3-in. depth of soil. The relationship between force and chart-line deflection was linear.

The lifting and lowering mechanism consisted of a plexiglass platform and a gearing arrangement attached to two 15-in.-long Acme screws. A ⅓-hp electric motor operated the Acme screws and lowered the soil sample onto the mechanical seedling at a constant rate. A variable-speed Grahm transmission varied the speed of the lifting and lowering mechanism from ¼ to 6 in. per minute.

The force on the mechanical seedling could be measured to 0.01 lb with the instrument at maximum amplifier sensitivity. The cantilever beam for position measurement was calibrated for a 4-in. displacement of the mechanical seedling, the position of which could be recorded to the nearest 0.1 in.

Procedure

Air-dry Brookston sandy loam soil† was screened through a U.S. No. 16 screen to obtain a uniform soil. The moisture content was adjusted by placing 2500 grams of soil in a container and adding the amount of water calculated to produce moisture contents of 12, 16, and 20 percent. (All soil moisture contents are expressed as percent dry-weight basis.) The container was sealed and the mixture was allowed to attain equilibrium during a period of 3 days. The container was shaken for a few minutes each day. The soil was again screened through a U.S. No. 16 screen to break clods formed during wetting of the soil and to insure a uniform moisture distribution. The container was sealed and at least one more day was allowed for the soil moisture to reach equilibrium. The soil was transferred to plastic boxes 7 in. long, 5 in. wide, and 4 in. deep. Nine holes had previously been drilled in the bottom of each box for passage of the mechanical seedling. The holes were covered from the bottom with masking tape. A soil depth of 3 in. after compaction was used in all experiments. A calibrated proof ring and a hydraulic press were used to apply the compaction pressures either to the soil surface or at a 1-in. depth. The mechanical seedling was pushed through the soil samples immediately after they were prepared and at predetermined later dates. The soil samples were stored in a constant-temperature room maintained at 70 deg F. In one experiment, the tops of the boxes were sealed to prevent loss of soil moisture. In all other experiments the tops were removed and the soil allowed to dry normally.

Mechanical seedlings with tip diameters of 0.078, 0.106, 0.162, and 0.274 in. were fabricated. The tip diameter of the mechanical seedling was larger than the stem diameter. This reduced adhesive frictional forces between soil and stem as the mechanical seedling passed through the soil. The 0.078-in. mechanical seedling is approximately the diameter of a corn seedling shoot. The average diameter of a protruding navy bean crook (Michelite variety) was 0.274 in. The velocity of the mechanical seedling while moving through the soil was held constant at 6 in. per minute.

All treatments were replicated at least four times. Each value for the graphs and tables is an average of four individual measurements.

The area under the force-versus-depth curve recorded by the oscillograph was determined with a planimeter and reduced to inch-pound units. This value was the energy exerted by the mechanical seedling during emergence.

Results

The four individual laboratory experiments conducted in this study are presented in chronological order, as follows:

Effect of Mechanical Seedling Diameter on the Force and Energy Required for Emergence. Mechanical seedlings were forced upward through a 3-in. depth of soil (16 percent moisture) which had received surface compaction pressures of ½, 2½, 5, and 10 psi. Non-drying conditions were maintained by keeping the boxes covered except during test. Mechanical seedlings of 0.078, 0.106, 0.162, and 0.274 in. in diameter were used.

The emergence energy (the energy required for emergence of the mechanical seedling) increased directly with seedling diameter and compaction pressure (Fig. 2). The larger increments of increase with diameter occurred at the higher compaction pressures.

The relationship between shearing position (the depth below the soil surface at which the inverted cone of soil shears from the main body of soil due to the force of the mechanical seedling), mechanical seedling diameter and compaction pressure for 16 percent soil moisture is shown in Fig. 3. The position of shear remained relatively constant as the compaction pressure increased; therefore, it appears that the depth of shearing position for a condition of no evaporation from the soil surface is independent of compaction pressure. The depth of shearing position depends upon the diameter of the mechanical seedling. The weight of the soil cone sheared by the seedling tip also increased with mechanical seedling diameter. The cone sheared from the soil by the mechanical seedling was similar in ap-

†Mechanical analysis was determined by Stout (7); ½ atm tension—17.4 percent dry basis (63 percent sand, 23 percent silt, and 14 percent clay); 15 atm tension—9.1 percent dry basis.

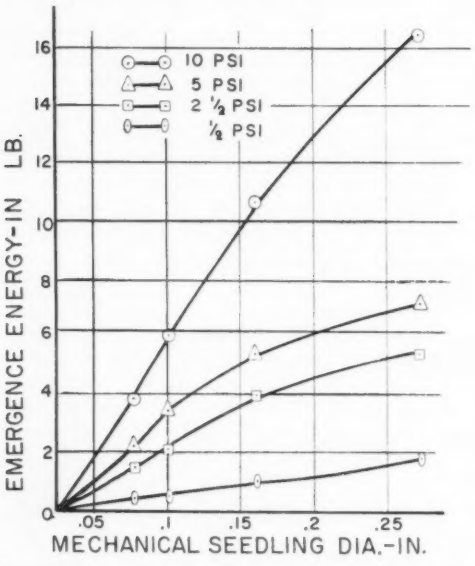

Fig. 2 Emergence energy versus mechanical seedling diameter for surface-compaction pressures of ½, 2½, 5, and 10 psi under non-drying conditions. Soil moisture content, 16 percent

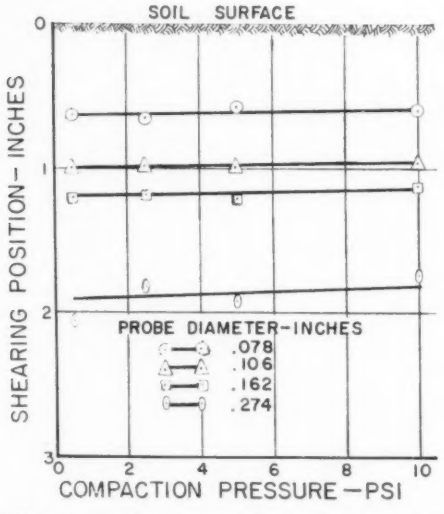

Fig. 3 Shearing position versus surface-compaction pressure for mechanical seedling diameters of 0.078, 0.106, 0.162, and 0.274 in. under non-drying conditions. Soil moisture content, 16 percent

pearance to the cones produced during the emergence of plant seedlings.

Table 1 presents maximum force, emergence energy, and shearing position data. The maximum emergence force also increased with seedling diameter and compaction pressure. The graphs for maximum force data are similar in shape to the curves shown in Fig. 2.

Effect of Soil Moisture Content, Compaction Pressure, and Drying on the Force and Energy Required for Emergence. Initial soil moisture contents of 12, 16, and 20 percent were used. Compaction pressures of ½, 1, 2, 4, 8, and 16 psi were applied to the soil surface. A mechanical seed-

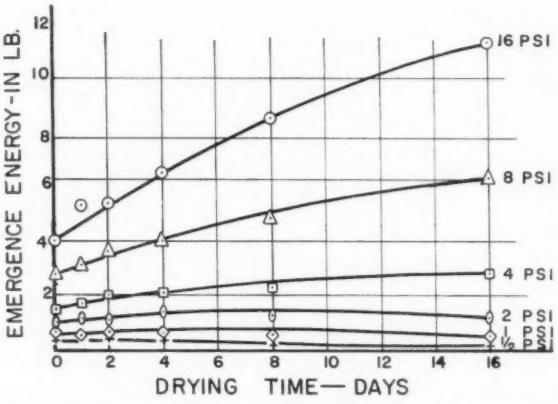

Fig. 4 Emergence energy versus drying time for surface compaction pressures of ½, 1, 2, 4, 8, and 16 psi. Initial soil moisture content, 12 percent

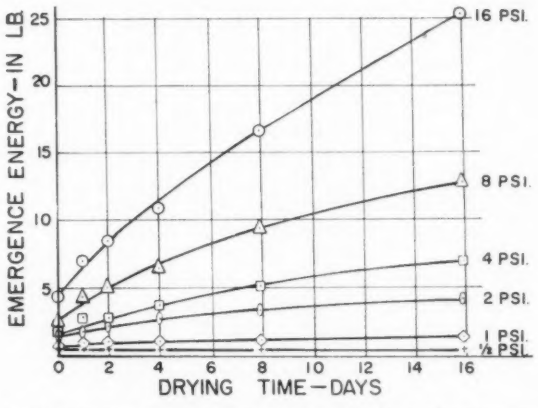

Fig. 5 Emergence energy versus drying time for surface-compaction pressures of ½, 1, 2, 4, 8, and 16 psi. Initial soil moisture content, 16 percent

TABLE 1. EMERGENCE ENERGY, MAXIMUM EMERGENCE FORCE AND SHEARING POSITION DATA FOR VARIOUS SURFACE-COMPACTION PRESSURES AND MECHANICAL SEEDLING DIAMETERS

Surface Compaction Pressure	Mechanical Seedling Diameter, Inches											
	0.078			0.106			0.162			0.274		
	Emergence energy	Maximum emergence force	Shearing position	Emergence energy	Maximum emergence force	Shearing position	Emergence energy	Maximum emergence force	Shearing position	Emergence energy	Maximum emergence force	Shearing position
psi	in.-lb	lb	in.	in.-lb	lb	in.	in.-lb	lb	in.	in.-lb	lb	in.
½	0.45	0.63	2.37	.563	0.14	0.97	1.07	0.29	1.20	1.79	0.573	2.05
2½	1.44	0.65	2.35	2.17	0.56	0.84	4.00	1.18	1.18	5.42	2.36	1.82
5	2.26	0.56	2.44	3.44	0.94	0.89	5.40	1.74	1.22	7.21	2.93	1.92
10	4.11	0.59	2.41	6.00	1.47	0.72	10.66	3.03	1.13	16.40	6.24	1.74

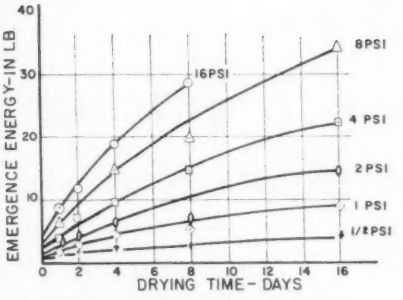

Fig. 6 Emergence energy versus drying time for surface compaction pressures of ½, 1, 2, 4, 8, and 16 psi. Initial soil moisture content, 20 percent

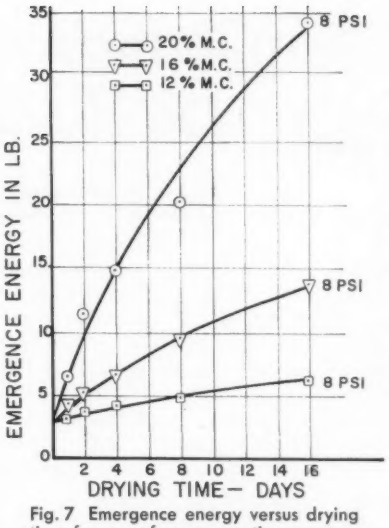

Fig. 7 Emergence energy versus drying time for a surface-compaction pressure of 8 psi and initial soil moisture contents of 12, 16, and 20 percent

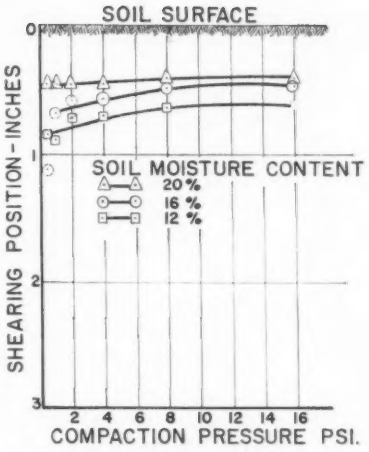

Fig. 8 Shearing position versus compaction pressure for initial soil moisture contents of 12, 16, and 20 percent under drying conditions of 8 days

ling (tip diameter, 0.078 in.) was forced upward through the soil samples immediately after they were prepared and 1, 2, 4, 8, and 16 days later.

The emergence energy increased directly with drying time, compaction pressure, initial soil moisture content, and inversely with moisture content at time of sampling (Figs. 4, 5, and 6). The rate of increase in the emergence energy with respect to drying time was the largest for the high compaction pressures. At initial soil moisture contents of 12 and 16 percent and low surface-compaction pressures, the emergence energy tended to decrease after a drying period of 8 days (Figs. 4 and 5). This can be explained by cracks in the soil surface caused by the compacting pressure and drying. The mechanical seedling emerged through these cracks, resulting in low values for the emergence energy.

In Fig. 7 the relationship between emergence energy and drying time is given for a surface compaction pressure of 8 psi applied at initial soil moisture contents of 12, 16, and 20 percent. These curves indicate that for a given compaction under drying conditions, the emergence energy increased directly with the initial soil moisture content. One explanation is that, in the soil moisture range used, the moist soils under a given pressure compacted to a greater bulk density and developed greater strength than soils at lower moisture contents. Greater mechanical strength was also produced in the surface layer when these moist soils were subjected to drying conditions. Curves of the same general shape were obtained for surface-compaction pressures of ½, 1, 2, 4, and 16 psi.

The depth of the shearing position (Fig. 8) of the cones below the soil surface under drying conditions changed only slightly with compaction pressure and length of drying time, and decreased as the initial soil moisture content increased.

Table 2 is a tabulation of the values for emergence energy, maximum emergence force, average emergence force, and shearing positions for various compaction pressures for a drying period of 8 days. Curves of the same general shape as shown in Figs. 4, 5, and 6 were obtained for the average and maximum emergence force.

The amount of moisture lost from the soil surface at moisture contents of 12, 16, and 20 percent for a drying period of 8 days is recorded in Table 3.

These data indicate that the largest moisture loss occurred at a compaction pressure of 16 psi for initial soil

(Continued on page 453)

TABLE 3. MOISTURE LOST FROM SOIL SURFACE INITIALLY AT VARIOUS MOISTURE CONTENTS AND COMPACTION PRESSURES FOR A DRYING PERIOD OF 8 DAYS

Surface compaction pressure	Initial Soil Moisture Content (Percent) 12	16	20
psi	grams	grams	grams
½	113.8*	113.5	234.0
1	117.5	123.5	268.3
2	118.0	132.0	260.8
4	119.3	136.0	290.8
8	120.0	135.5	308.7
16	126.3	156.5	323.0

*Moisture lost by evaporation from soil surface.

TABLE 2. EMERGENCE ENERGY, MAXIMUM FORCE, AVERAGE FORCE, AND SHEARING POSITION DATA FOR VARIOUS INITIAL SOIL MOISTURE CONTENTS AND SURFACE COMPACTION PRESSURES FOR A DRYING PERIOD OF 8 DAYS

	Initial Soil Moisture Content (Percent) 12				16				20			
Surface compaction pressure	Emergence energy	Maximum emergence force	Average emergence force	Shearing position	Emergence energy	Maximum emergence force	Average emergence force	Shearing position	Emergence energy	Maximum emergence force	Average emergence force	Shearing position
psi	in. lb	lb	lb	in.	in.-lb	lb	lb	in.	in.-lb	lb	lb	in.
½	0.18	0.08	0.03	1.05	0.52	0.19	0.09	0.75	2.55	0.90	0.43	0.43
1	0.58	0.16	0.07	1.17	1.24	0.41	0.21	0.78	5.48	2.06	0.93	0.39
2	1.27	0.32	0.22	0.95	3.43	1.20	0.58	0.64	7.42	2.58	1.26	0.41
4	2.31	0.59	0.39	0.75	5.25	2.03	0.89	0.57	14.83	4.72	2.51	0.34
8	4.90	1.51	0.82	0.70	9.58	3.28	1.67	0.51	20.17	6.75	3.42	0.18
16	8.50	3.05	1.44	0.66	16.72	5.48	2.84	0.60	29.10	7.88	4.93	0.19

Agricultural Applications of the Dual-Monochromator Spectrophotometer

Instrument measures optical-density differences of intact farm products

G. S. Birth
Assoc. Member ASAE

THE recently developed technique for measuring light-transmittance properties of agricultural commodities has many possibilities for research and practical application. This technique has been useful in evaluating the color of tomatoes (4)*, maturity of peaches (12), smut content of wheat (1), discoloration in potatoes (2); in detecting blood spots in eggs (6) and in other similar problems of evaluating quality of agricultural products. These problems are related to the composition of the product. Frequently the constituent which is related to the quality factor in question will have an absorption band in the spectral region where light can be transmitted through the product, and an optical-density measurement at or near the absorption band can be related to the concentration of the constituent. An optical-density measurement at a single wave length is influenced by variations in the size of sample, light output of the lamp, and sensitivity of the detector. Measurement of the optical density at two wave lengths and computation of the optical-density difference (ΔOD) can be used to cancel the effect of these variables and give a number which is a function of composition only.

In situations where the most desirable wave lengths have been established, the difference measurement can be made very rapidly with the proper instrumentation, but it is a relatively time-consuming procedure when using a single-beam spectrophotometer either with recorded curves or by reading the instrument directly. In 1951 Chance (9) described an instrument, consisting of two grating monochromators, which was developed to make very sensitive measurements of optical-density differences in the optical-density range between 0.00 and 2.00.

The dual-monochromator spectrophotometer described in this paper was developed to provide an instrument of relatively simple design and having a wide optical-density range (0.00 to 6.00) for measuring optical-density differences of intact agricultural products (Fig. 1).

Design Considerations

The basic requirement for an instrument to measure optical-density differences of agricultural products is that two independent monochromators must be incorporated into a single instrument. The monochromators should cover the spectral region from 500 to 1000 mμ. Optics to focus the beams from both monochromators on the sample and a method of coding one or both light beams are required. A sample compartment is needed which will eliminate ambient light, provide a high energy level for the detector and integrate the transmitted light to compensate for non-uniformity of samples. It is desirable to measure the energy level without the use of any manual gain control even though the energy level of the transmitted light may vary by a factor of 10^6. Electrical circuits to compute the optical-density difference between the two light beams and display this value on a suitable meter with appropriate zero control, sensitivity attenuator and test switch for checking various parts of the circuit are needed.

Optical Design

The optical system (Fig. 2) is in a vertical plane and symmetrical about a perpendicular vertical plane through the lamp filament. The two light beams are identified as "Beam A" on the left and "Beam B" on the right. A single lamp is used as the light source for both monochromators so that variations in light output appear in both beams. Thus the optical-density difference is independent of changes in lamp intensity. The lamp is a 6-v, 100-w projection lamp with a closely coiled filament providing a concentrated source symmetrical about a vertical plane. A short-focal-

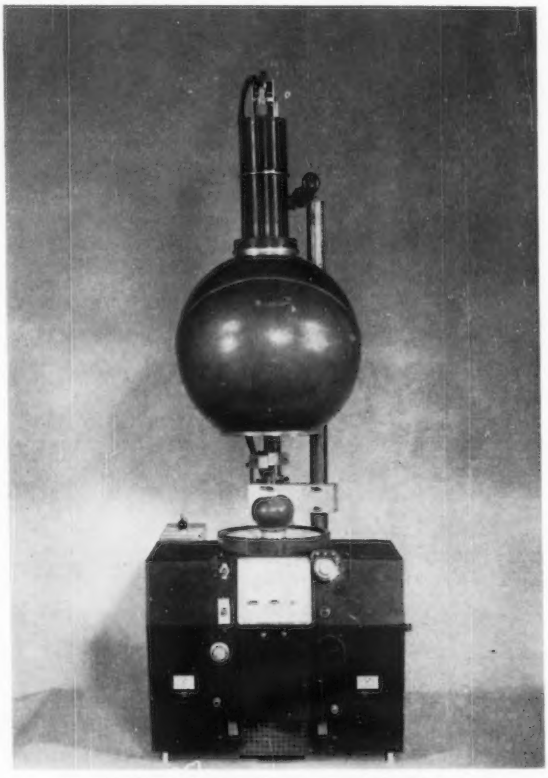

Fig. 1 The dual-monochromator spectrophotometer

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged by the Electric Power and Processing Division.

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*Numbers in parentheses refer to the appended references.

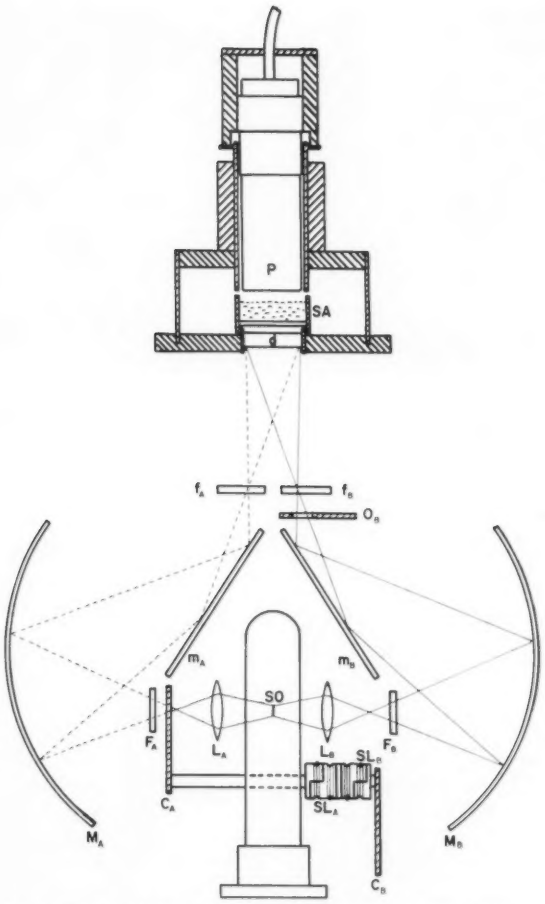

Fig. 2 Optical design of dual-monochromator spectrophotometer, the optical components of which are as follows: SO, lamp; L, lens; C, chopper blade; F, wedge interference filter; M, spherical mirror; m, plane mirror; O, optical attenuator; f, optional filter; d, diffusing plate; SA, sample; P, phototube; and SL is the slip ring on the chopper shaft. The subscripts refer to the light beams A and B

length lens is mounted on each side of the lamp to collect light for the two beams. Wedge-interference filters are used for the dispersion elements of the monochromators. The chief advantages of the wedge-interference filter are that it is inexpensive, rugged and can be used to design a relatively simple compact monochromator to operate at a high energy level (3). The major disadvantage of the wedge-interference filter for this application is that it passes too much stray light; i.e., about one part in 200. Minor disadvantages are that the minimum bandwidth is about 12 mμ, and extra order wave length bands are transmitted. Because the monochromators were to be set at certain fixed wave lengths, or possibly were to scan a narrow region of the spectrum, these problems were overcome by the use of optional filters and proper selection of the phototube. Wedge-interference filters which are readily available at low cost cover just the visible spectrum, so provision was made to isolate other wave lengths in this instrument by means of optional filters.

Five-inch spherical mirrors are used to focus the monochromatic light on the sample. The light beams, after reflection from the spherical mirrors, strike plane mirrors and are reflected to the sample. With this arrangement the angle between the incident and reflected beams on the spherical mirrors is kept small so the image of the lamp filament formed on the sample is not distorted too much. A holder for inserting optional filters in the light beams is located about 2 in. below the sample position. The light beams have a minimum cross section (¾-in. diameter) at this point, and 2 x 2-in. filters with a maximum total thickness of ¾ in. can be introduced in each beam. An optical attenuator is located next to the optional filter holder in beam B.

A chopper for coding the light beams interrupts the beams between the lens and the wedge filters. The light beam has a minimum cross section at this point (¼-in. diameter); thus, the physical size of the chopper is small, and only 15-deg rotation of the chopper blade is required to block the light beam.

The method chosen to code the light beams is to block them alternately so that only one beam strikes the sample at a time and simultaneously to make an electrical switching operation. The chopper consists of two semicircular blades. The blades are mounted on each end of a 4-in. steel shaft and are positioned 180 deg out of phase with each other. The chopper is belt driven at 1080 rpm by a small shaded-pole electric motor. There are two slip rings mounted on the chopper shaft to provide the electrical switching synchronized with interruption of the light beams. A spanner wrench can be used to rotate either slip ring on the chopper shaft to adjust the synchronization. As the chopper blades rotate, the open beam is uninterrupted for about 165 deg rotation of the chopper blade. The slip rings on the chopper shafts are designed to cover a 160-deg arc; thus switching on the chopper occurs so that there is electrical continuity for only the time during which the corresponding light beam is totally uninterrupted.

A 12-in. integrating sphere similar to that described by Norris (10) is used to collect the light transmitted by the sample. An end-window, multiplier-type phototube is mounted at the apex of the sphere (Fig. 1). In situations where the sample is appreciably smaller than the photocathode area of the phototube, the phototube can be mounted next to the sample. In such an arrangement most of the light transmitted by the sample strikes the phototube directly; consequently, there is no need to integrate the transmitted light. This design is termed the "direct phototube mount". A cross section of this assembly is shown in Fig. 2. With small samples more energy reaches the phototube with the direct phototube mount than when using the sphere. The sphere is used for large samples (apples, tomatoes, etc.), and the direct phototube mount is used for small samples (seeds, small fruits and solutions). A diffusing plate is mounted immediately below the sample so the illuminated portion of the sample will be illuminated uniformly by both beams.

Electrical Design

The circuit for the photometer and the voltmeter of the dual-monochromator spectrophotometer is shown in Fig. 3. The photometer consists of a ten-stage, multiplier-type phototube operated with constant anode current. The author described the operation of this circuit in 1959 (1). The voltage level varies approximately as the logarithm of the

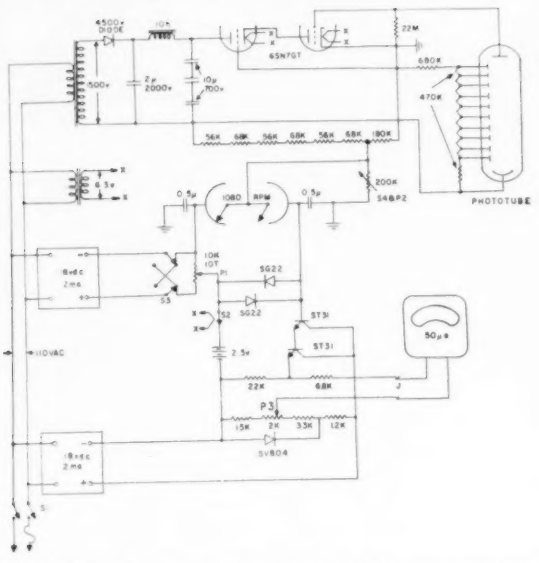

Fig. 3 Photometer and voltmeter circuits of the dual-monochromator spectrophotometer. The controls for this circuit are: S1, on-off switch for the photometer; S2, delay relay for closing the battery circuit; S3 and P1, zero adjustment; S4 and P2, sensitivity adjustment; P3, impedance adjustment for the voltmeter; J, recorder jack. The circuit for the test switch is not shown.

reciprocal of the energy incident on the photocathode surface of the phototube or in direct proportion to the optical density of the sample. The optical-density versus voltage calibration curve is shown in Fig. 4. There is good linearity for optical-density levels from 2 to 5, and the best sensitivity is obtained in this region.

The phototube voltage is applied to a sensitivity attenuator through a series of voltage-dropping resistors. The voltage at the attenuator is applied to the common lead of the slip ring and brush assembly on the chopper shaft. A capacitor is charged in proportion to the voltage applied to the phototube when the corresponding light beam is being transmitted through the sample. As the chopper rotates and the other beam is incident on the sample, another capacitor is charged. A high-impedance transistorized voltmeter is

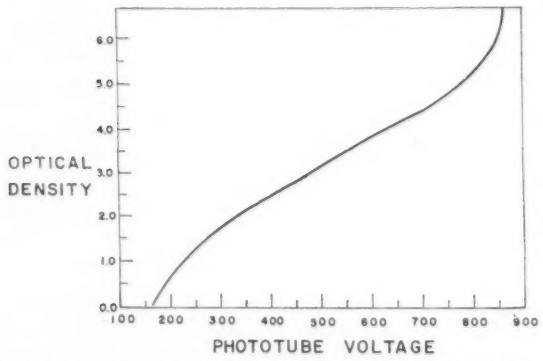

Fig. 4 Optical-density vs. voltage calibration curve of the constant anode-current photometer using a Dumont K1292 infrared phototube. The linearity is reasonably good between an optical density of 2.0 and 5.0

used to measure the voltage differences between the two capacitors. The voltmeter has a sensitivity of about 0.6 v full scale and draws less than 1 μa to prevent discharging the capacitors excessively. Two SG22 diodes are used to protect the voltmeter from overloads. Miniature direct-current supplies provide the power for the transistor amplifier and the zero-control circuit. A 2.5-v battery provides the bias for the transistor amplifier. The battery circuit is closed with a thermal-delay relay so there is no current drain on the battery when the system is not energized regardless of what may interrupt the voltage to the instrument.

A test switch is incorporated to indicate certain critical voltages at ten different positions in the circuit; e.g., battery, direct-current supplies, etc. The phototube voltage can be measured in this manner and is used to indicate the energy level at the phototube. The instrument controls are identified in Fig. 5.

Mechanical Design

The base of the dual-monochromator spectrophotometer is ⅜-in. plate aluminum reinforced with ¾ by ⅜-in. aluminum bars. The principal framework of the instrument is made of aluminum angles and T's. This framework supports the housing over the lamp, the wedge-interference filters, the plane mirrors, holders for the optional filters and the integrating sphere when in the closed position. The lamp housing forms a continuous compartment through the center of the instrument. The lamp socket is mounted on a slide which can be easily removed at the front of the instrument for replacing the lamp. The chopper is a self-contained unit and is mounted directly back of the lamp in the lamp compartment. The chopper blades are mounted in close proximity to the walls of the lamp compartment. The openings in the walls of the lamp compartment for the light beams are about ¼ in. in diameter. The lenses form an image of the lamp filament (approximately ⅛ by ½-in.) on the wedge filters, and slits are mounted on the other side of the filters so that there are two relatively small openings about ½ in. apart in each optical path; thus, when the chopper blades rotate, the blocked beam is eliminated to about one part in a million.

The wedge-interference filters are moved horizontally by means of threaded rods; small three-digit counters coupled to the rods with bevel gears provide a method of reading the wave length directly. By using 28 threads per inch on the rod and a two-to-one reduction from the rod to the counter, a fairly close calibration is obtained between the counter and the wave length of light passed by the wedge-interference filter. Small cranks on the ends of the threaded rods provide a means of manually changing wave length; shaft locks are included to maintain the monochromators at the set wave lengths. The monochromators can be adjusted to completely remove the wedge-interference filters from the light beams to provide for isolating wave lengths beyond the range of the filters. A 10-rpm electric motor is geared to the other end of the threaded rod of the B monochromator for scanning the spectrum to record spectra; a multiturn potentiometer is also connected to the shaft at this point for driving the X-axis of an X-Y recorder. Limit switches are placed on the monochromator to prevent overdriving the monochromator.

Modified drill press stands are used to raise and lower the sphere and the direct phototube mount for access to the

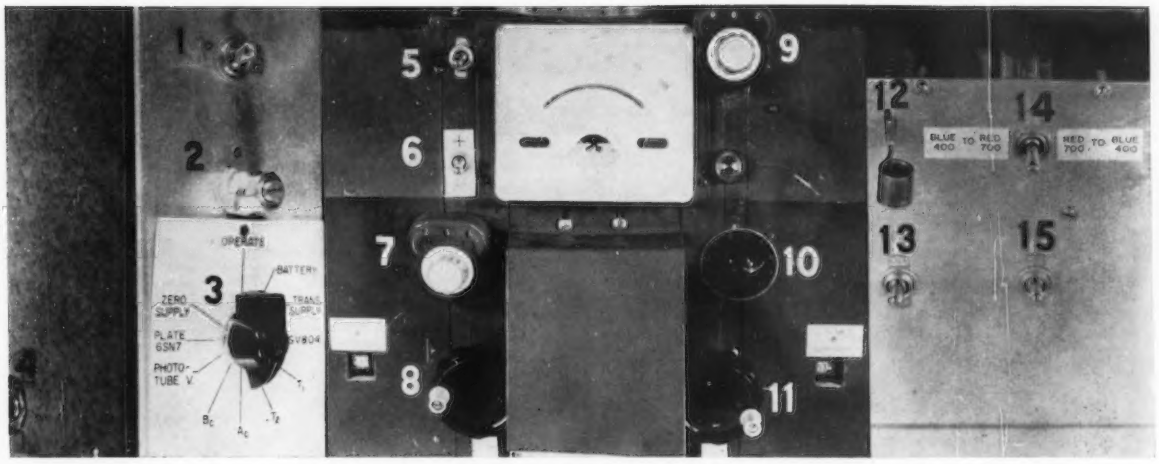

Fig. 5 Controls of the dual-monochromator spectrophotometer: (1) On-off switch for the photometer; (2) impedance adjustment; (3) test switch; (4) recorder jack; (5) main on-off switch for entire instrument; (6) two-position zero switch; (7) continuous zero adjustment; (8) wavelength control (beam A); (9) continuous sensitivity adjustment; (10) 11-position sensitivity switch; (11) wavelength control (beam B); (12) wavelength drive engagement lever; (13) chopper on-off switch; (14) wavelength drive on-off and direction-control switch; and (15) lamp on-off switch. (The output jack, switch and zero control for driving the X axis of an X-Y recorder and a control for the optical attenuator are located at the back of the instrument and are not shown)

sample position. An axial flow muffin fan is mounted at the rear of the lamp compartment to remove the heat produced by the lamp. A fiberglass filter is placed over the front of the lamp compartment to keep dust out of the instrument. Removable metal housings are placed over the sides of the instrument to cover the monochromators. All exposed components in the monochromators, except the lenses, mirrors, etc., are painted with a flat black paint to eliminate specular reflectance. The electronic circuit is on a 7 x 10-in. chassis which is mounted vertically at the rear of the instrument.

Performance

Normal operation for the dual-monochromator spectrophotometer is to set the monochromators at preselected wave lengths, then adjust the sensitivity and zero controls so one extreme condition of the sample reads about zero and the other extreme 100. The best sensitivity and noise are obtained if the phototube voltage is between 400 v and 700 v and the transmitted light beams are nearly balanced. These conditions can be obtained by using screens in the optional filter holder and adjusting the optical attenuator.

Linearity of the system is about ± 1.25 percent with a sensitivity of 1.5 Δ *OD* full scale; with more than 1.5 Δ *OD* full scale, non-linear errors will be introduced. Calibration can be easily checked by introducing calibrated screens in the light beam with the optional filter holder. The maximum sensitivity is limited by the noise level. Fig. 6 shows the noise to be equivalent to an optical-density change of 0.001; thus the minimum optical-density change that can be detected is 0.001 when the response speed is 0.5 sec for 90 percent of full scale.

Applications

The chief advantages of the dual-monochromator spectrophotometer are the speed and sensitivity with which optical-density difference measurements can be made. This enables a research worker to detect extremely low levels of pigment concentrations in biological tissue. These measurements can be made much more rapidly than with conventional chemical extraction procedures. In many cases the Δ *OD* measurement can be made non-destructively, providing a method of observing changes in pigment concentration during physiological processes such as ripening. In situations where the instrument has been adjusted for a particular application the measurement can be made very rapidly. During a test with apples the average time per apple was 20 sec with one person handling the entire operation. Most of the 20 sec was used in handling the fruit and recording data. With mechanical handling of the fruit a speed of approximately one fruit per second would be the maximum theoretical speed that could be obtained with this instrument. Another design would be used to attain high speed automatic sorting as described by Powers *et al* (11).

One application of the dual-monochromator spectrophotometer is the rapid estimation of the chlorophyll content of peaches for maturity studies. The chlorophyll absorption band used in this work is 675 mμ; however, in the case of green peaches the absorption at 675 mμ is too great to be measured accurately. In absorption spectra of intact tissue the absorption bands are more intense than in clear solutions(7). The optical-density difference between 695 mμ and 725 mμ; i.e., Δ *OD* (695-725), was used as the index of chlorophyll content with this instrument. The optical density at 695 mμ is related to the presence of chlorophyll, while the optical density at 725 mμ is nearly independent of chlorophyll content. In a test calibrating the instrument for the chlorophyll content of Elberta peaches, the logarithm of the chlorophyll content gave a linear correlation of 0.939 with the Δ *OD* (695-725) (Fig. 7). The one point (7, 0.304) which falls out of the scatter plot is probably an error in recording the meter reading. The chlorophyll extraction procedure, a modified AOAC procedure, and additional results obtained with the dual-monochromator spectrophotometer are given by Sidwell *et al* (12).

(Continued on page 452)

Logarithmic Dosage Sprayer

Provides variable dosages for experimental plot applications

W. E. Yates and F. M. Ashton
Assoc. Member ASAE

RESEARCH scientists in agricultural chemical industries, governmental agencies, universities, and extension services each year are evaluating the biological effects of thousands of agricultural chemicals. In 1955, Pfeiffer *et al* (1)* introduced a variable-dosage sprayer that greatly reduced the time and space requirements for experimental plot applications. The unit applied a constant total volume, with the chemical concentration decreasing logarithmically with distance traveled. Thus a wide range of chemical concentrations could be applied in a single plot. Interest was widespread, and several types of machines have been introduced (2, 3, 4, 5, 6). This paper discusses the general design criteria, critical components, construction, calibration, and operation of a simple, complete, lightweight "logarithmic" dosage sprayer. Typical field results are also discussed.

Theoretical Relationships

The system employs a two-vessel arrangement (Fig. 1). In operation, tank B is filled with the maximum chemical concentration desired and tank A is filled with a diluent. As the spray is discharged from tank B, it is constantly replaced as an equal quantity of diluent is mixed into the tank. Theoretically the concentration can be expressed in the following relationship:

Symbols	*Units*
x, concentration of chemical in vessel B	pounds per gallon
x_o, initial concentration in vessel B	pounds per gallon
t, time	minutes
r, flow rate of spray	gallons per minute
v, volume of vessel B	gallons
s, forward speed of sprayer	feet per minute
d, distance traveled	feet
g, total volume sprayed	gallons

If tank A contains only diluent and tank B contains diluent and spray that is always thoroughly mixed,

$$\frac{dx}{dt} = (\text{rate of gain}) - (\text{rate of loss}) = o - \frac{r}{v}(x)$$

$$\int_{x_o}^{x} \frac{1}{x}\,dx = -\frac{r}{v}\int_{o}^{t} dt \;;\; \log_e\left(\frac{x}{x_o}\right) = -\frac{r}{v}(t)$$

or

$$2.303 \log_{10}\left(\frac{x}{x_o}\right) = -\frac{r}{v}(t) = -\left(\frac{r}{v}\right)\left(\frac{d}{s}\right) \quad . \quad . \quad [1]$$

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*Numbers in parentheses refer to the appended references.

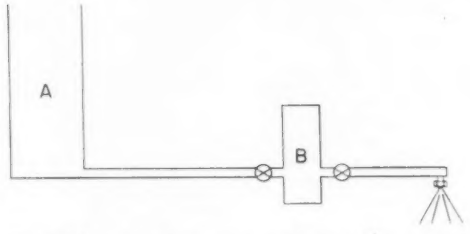

Fig. 1 Schematic of spray system, Vessel A contains diluent, Vessel B contains the chemical and diluent mixture

The above equation relates the chemical concentration of the spray with the common operational factors. The "half-life" and "half-distance" are convenient terms for indicating the characteristics of a given system. These values represent the time and distance of sprayer operation that result in twofold dilution of the spray. Thus, from equation [1] let

$$\frac{x}{x_o} = \tfrac{1}{2};\ \text{then}$$

$$\text{"Half-life,"}\ t_{1/2} = 0.693\,\frac{v}{r}\ \text{min} \quad . \quad . \quad . \quad . \quad [2]$$

$$\text{"Half-distance,"}\ d_{1/2} = 0.693\frac{v}{r}(s)\ \text{ft} \quad . \quad . \quad [3]$$

Fig. 2 graphically illustrates a logarithmic application with a "half-distance" of 20 ft. Thus, for each 20 ft of travel, A-B, B-C, etc., the concentration is reduced one-half. For example, the concentration is one-half of the initial concentration at 20 ft, one-quarter at 40 ft, one-eighth at 60 ft, etc.

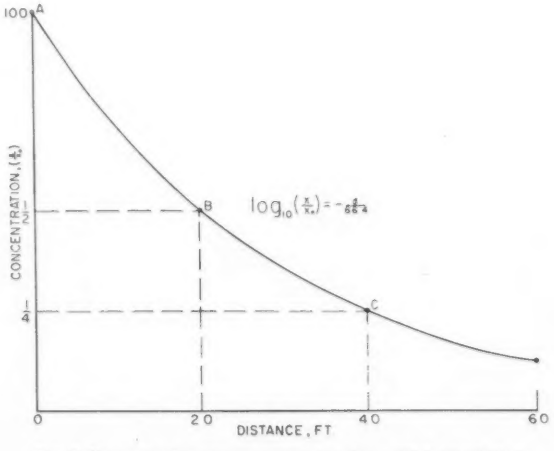

Fig. 2 Theoretical spray concentration for a 20-ft "half-life" logarithmic application

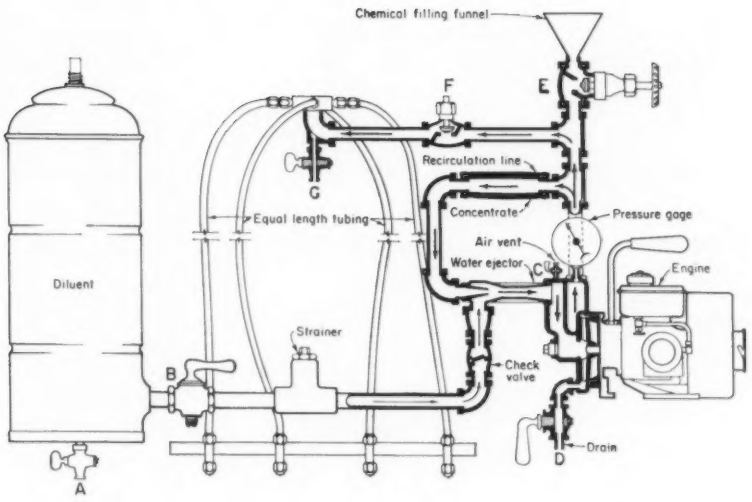

Fig. 3 Flow diagram of sprayer components

Sprayer Design

The performance of a logarithmic sprayer depends on a few critical design criteria. The most important factors are volume of concentrate tank, adequate mixing of solution in concentrate tank, uniform ground speed, and constant flow from the sprayer. These factors must be integrated with the specific requirements for a given application. Generally the scientist will specify the desired "half-distance," application rate (gallons per acre), and plot width for experimentation in a given area. The above factors can be expressed mathematically as

$$r\ (\text{gal/min}) = \frac{(\text{No. of noz.})\ (\text{Noz. spacing, ft})\ (\text{gal/acre})\ (S,\ \text{ft/min})}{43560} \quad . \quad . \quad . \quad [4]$$

Equations [3] and [4] can then be reduced to:

$$d_{1/2} = \frac{30187(v)}{\sqrt{(\text{No. of noz.})\ (\text{Noz. spacing, ft})\ (\text{gal/acre})}} \quad . \quad [5]$$

Thus from equation [5] the specific volume of the concentrate vessel required for a particular set of conditions can be accurately determined. It should be noted that, if the concentrate volume is a fixed value for a particular machine, the "half-distance" can be changed only by altering the total application rate (gallons per acre) or effective width of the sprayer.

Sprayer Construction

The flow diagram (Fig. 3) indicates the relationship of the basic sprayer components. The centrifugal pump (Crown, model PUP), water ejector (Penberthy, series 63A) and recirculation line form the "concentrate" vessel and its necessary mixing system. The water ejector unit, with a 13/64-in. jet and a ½-in. mixing throat, performs two important functions: intimately mixes the entrained diluent with the chemical concentrate, and regulates the rate of recirculation. The combination is also similar to a jet pump installation, and for typical spray rates (1 to 3 gpm) it provides a greater spray pressure than available from the centrifugal pump alone. To ensure satifactory operation, the size of ejector must be matched with the hydraulic characteristics of the system. At normal spray rates of 1 to 3 gpm the above system produces a maximum spray pressure of 60 psi and a recirculation rate of 9.1 gpm. Valves A, B, C, D, E, and G – used in field operation for filling, venting air from system, and draining the component parts after application – may be simple stopcock-type units. A ratchet-action ball valve F (¾-in. Bes-Val), with teflon seats, was used to control the main spray and is rapidly actuated by a simple linkage from the handle-bar grip.

Fig. 4 illustrates a complete lightweight unit designed and constructed for experimental applications of herbicides. A portable, adjustable framework was fabricated from two 26-in. bicycle wheels, 1¼-in. square tubing with a ⅛-in. wall thickness, and lightweight EMT tubing. A short cylindrical manifold with outlets equally spaced around the circumference distributes the spray to an equal length of tubing for each nozzle, mounted on the offset adjustable boom. A bitumeter (Model 702-D Stewart-Warner recording bitumeter) is chain-and-gear-driven with a speed increase of four times normal. This provides accurate scale

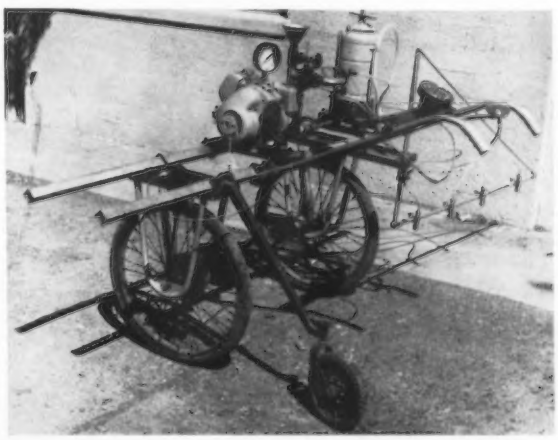

Fig. 4 Complete logarithmic dosage sprayer

readings of speed (full scale, 375 fpm) and distance traveled.

Calibration

Successful use of a variable-dosage sprayer requires easy and accurate prediction of chemical concentration. The complete machine, with four spray nozzles, was calibrated for flow rate and rate of chemical dilution. Three different flat fan nozzles — Nos. 8003, 8004, and 8006 (Spraying Systems "Teejets") — were used in testing three flow rates and the corresponding "half-lifes." The respective rates at 60 psi manifold pressure were 1.42, 2.00, and 2.65 gpm. The concentrate tank was filled with a water-soluble chemical (manganese sulfate) of known concentration, with water in the diluent tank. Spray samples were collected at two-second intervals for each of the above arrangements.

The samples were quantitively analyzed with a flame spectrophotometer. The concentration ratios are plotted in Fig. 5. The theoretical curves of concentration versus time for each calibrated flow rate with a concentrate tank volume of 0.385 gal were computed from equation [1] as follows:

$$\log_{10}\left(\frac{x}{x_o}\right) = -\frac{rt}{2.303v} = -\frac{rt}{0.887}$$

Plotting this relationship on semilog paper yields the three theoretical straight lines illustrated in Fig. 5. The close agreement of experimental values and the theoretical curve indicates that the design provides adequate mixing of the chemical and diluent over the range of flow rates tested.

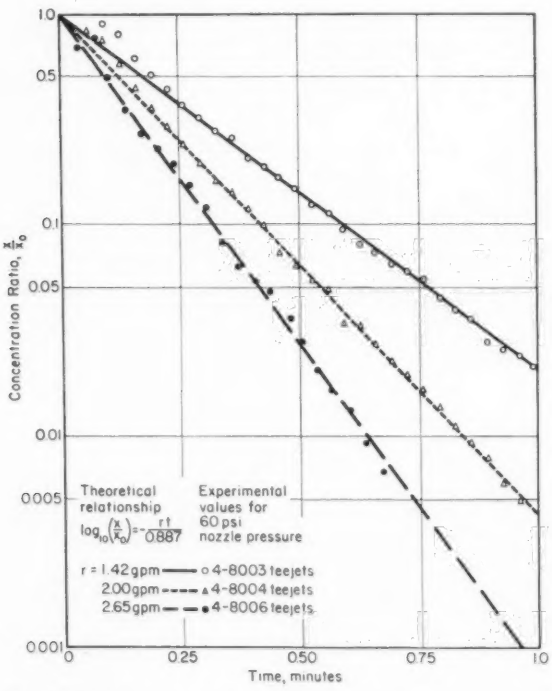

Fig. 5 Comparison of theoretical spray concentration curves and experimental spray concentration values obtained from the described sprayer

Thus equations [1], [2], and [3] can be used directly for computing field performance of the machine. Example: Given the following basic conditions, calculate the "half-distance" and application rate: 4 No. 8004 nozzles, $r = 2.0$

(Continued on page 442)

Fig. 6 Photographs of portions of the weed control plot (Tables 1 and 2) from top to bottom; 0 ft, 20 lb per acre; 15 ft, 10 lb per acre; 30 ft, 5 lb per acre; 45 ft, 2.5 lb per acre

Design of Irrigation Border Checks

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THE statement that a border check has been designed implies that some attempt has been made to specify those variables within the control of the builder so that optimum performance may be reasonably expected to result. Performance is generally desired to be optimum with respect to a number of factors, including efficiency of water use, uniformity of application, minimum erosion, minimum deep percolation, efficient leaching, minimum construction cost, and minimum operating cost. These factors are all components of either maximum long-range production or of minimum long-range costs.

"Design" of a system usually (but not always) implies that the specification of the variables is based on predictions of the behavior of the system. In the case of border checks, however, our ability to predict the behavior of the system has been somewhat less than desirable. Consequently, most "well-designed" border checks are based on the evaluation of previously constructed systems on the same or similar soils under the same or similar conditions. One could also add that, because of these problems, many more border-check irrigation systems are built than are designed.

Some progress has been made on the predictions of the time-distance relationships of the advancing water front [Lewis and Milne, (3)*; Hall (2)]. Studies are currently being undertaken to describe more adequately the hydraulics of shallow rough-surface flows, on which more refined calculations may be based. It would appear that the time is approaching when border checks can be truly designed from a prior knowledge of soil, topography, land use, etc., without the expensive trial-and-error method of construct, evaluate, and modify.

The following paragraphs are intended as a possible method of specifying the physical characteristics and operating procedures of a border system for the purpose of obtaining maximum application efficiency. No comments are made concerning the other factors to be optimized, such as erosion and salinity control, uniformity of application, etc., except as they are improved by increased application efficiency. These factors and the extent to which they can be controlled have been discussed elsewhere.

The basis of the design is the calculation of the rate of advance from the observed or expected infiltration characteristics, the allowable range of slope, the possible values of roughness and puddle factor, and the maximum allowable stream size. The limits of stream size and slope are presumed to be specified on the basis of existing or "as improved" procedures for minimizing erosion, leveling costs, soil profile and the water source.

Paper prepared expressly for AGRICULTURAL ENGINEERING.

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*Numbers in parentheses refer to the appended references.

Proposed method of specifying a border system for maximum application efficiency

NOMENCLATURE

B = Volume balance function in cubic feet per foot of check
B_d = Design volume balance function, cubic feet per foot of check
f = Factor of ignorance
L = Length of the border check in feet
q = Rate of inflow to the check in cubic feet per second-foot of check
q_d = Rate of application as designed in cubic feet per second-foot of check
T = Period of time water flows onto the check in seconds
V_a = Volume of water applied to the check in cubic feet per foot of check
V_r = Volume of water required for the design depth of irrigation in cubic feet per foot of check
Y = Accumulated or total depth of water entering the soil at any point in feet
Y_o = Total depth of water entering the soil at the head of the check in feet
Y_d = Design depth of application in feet
η = Application efficiency.

Design Procedure for Optimum Efficiency

Presume that considerations other than application efficiency have been analyzed so that the limitations on stream size, the range of economic slope, the water source, etc. are known. Let q represent the stream size in cubic feet per second per foot width. Then q_{max} is the maximum permissible stream. The slope may range from S_{min} to S_{max}. The irrigation schedule and the water-holding capacity of the soil is such that a depth of application Y_d will probably be required at each irrigation. Variable time is represented by t, while T corresponds to the total length of time that the stream is turned into the border check. Distance down the border will be denoted by x. The total length of the run is designated by L. For practical reasons, in most cases L must be equal to the length of the field or an integral fraction thereof. Presumed known is the accumulative depth of infiltration function, $y(t)$, in cubic feet per square foot.

The first step in the procedure is to calculate a family of advance curves using the field data for $y(t)$. Time is plotted as ordinate with distance as abscissa and rates of discharge as parameter. Calculations for the first trial are made for the most economic slope, S, the probable roughness, n, and probable puddle factor, e, using the numerical procedure outlined in a previous article (Hall, 2). This procedure has been programmed for the Bendix 101 digital computer which greatly simplifies the task of obtaining these curves. The resulting calculations for a set of conditions

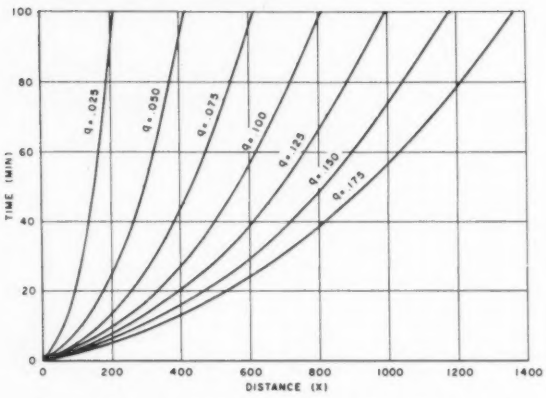

Fig. 1 Calculated position of water front for different rates of discharge

similar to that described by Criddle and Davis (1) are shown in Fig. 1.

Some observations concerning the border check may be made. The volume of water admitted to the check per unit width is equal to the rate of discharge multiplied by the length of time the water is on. For preliminary design purposes, postulate that this period of time is also equal to T, the time required for the advance to reach the end of the border $x=L$. The volume of water applied is then

$$V_a=qT \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

The minimum volume of water per unit width required to apply a depth of at least Y feet (corresponding to T intake opportunity time) over the entire border length, L, is

$$V_r=YL \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

Continuity considerations require that the volume admitted to the check must at least equal the volume required. The first design criterion is, therefor

$$qT \geq YL \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

As the second step of the design procedure, construct a volume balance function $B(q, T, Y, L)$ equal to the difference between the volume of water admitted to the check, qT, and the volume of water applied to the soil presuming that a uniform depth Y_o corresponding to an intake opportunity time T is added to the entire field.

By definition

$$B=qT-Y_oL \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [4]$$

In the usual case, there is a given maximum length of run corresponding to the entire field length. The border itself must be some even fraction of this length (½, ⅓, ¼, ⅕, etc.) if all borders are to be equally effective. The function B is therefore constructed for each possible and probable field length L_1, L_2, L_3, etc. If there is no restriction on the length, then any suitable lengths L_1, L_2, etc., may be taken. The procedure for constructing B (with L_1 as parameter) is to determine the time T required for each flow to reach a distance L_1 using the advance curves (Fig. 1). This determines a value for T and Y_o for each q. The corresponding values of B for $L=L_1$ are calculated from equation [4] and plotted as ordinate against Y_o as abscissa as in Fig. 2. The process is repeated for L_2, L_3, L_4, etc., giving a family of curves B versus Y_o with L as parameter. The data plotted in Fig. 2 also correspond to the situation described by Criddle and Davis (1).

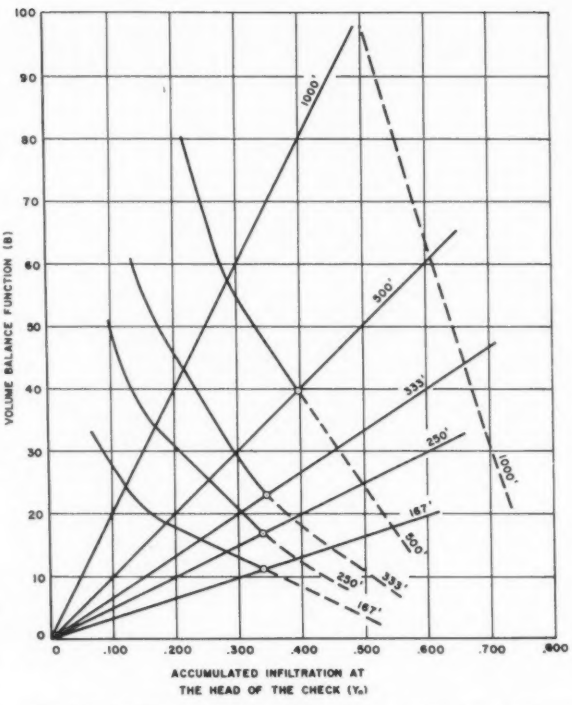

Fig. 2 Determination of most efficient border using the volume balance function

Only values of the volume-balance function which are greater than zero represent solutions which may possibly apply a depth equal to Y_o over the entire length of border. In fact, to allow for non-uniformities and non-parallel advance and recession curves, only values of B greater than some minimum positive value, B_d, can be expected to accomplish the purpose of the irrigation. We now set

$$B_d=fYL \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [5]$$

where f represents a "factor of safety" or a "factor of ignorance" depending upon the point of view. This function is represented in Fig. 2 by the pencil of straight lines passing through (0, 0). The lines are shown for the corresponding trial border lengths for a constant factor of ignorance of 0.20.

The intersection of $B(Y_o)$ for L_1 and $B_d(Y_o)$ for L_1 represents the minimum value of B which can be accepted for that length of border, since lower values will not provide an adequate irrigation to at least a part of the field. It also represents the point of optimum application efficiency for the particular border length since larger values of B represent a greater than necessary surplus of water admitted to the check.

Knowing the point of maximum efficiency for each possible border length, the optimum border length may be se-

lected. The intersection nearest to, yet larger than, the design Y_d will represent the optimum length.

For example, in Fig. 2, if a depth of application at each irrigation equal to 0.4 ft is desired, the optimum border length is 500 ft. If a depth of application of 0.35 ft is desired, the optimum border length is 333 ft. If a depth of application of 0.3 ft is desired, the optimum length will be less than 167 ft.

With the optimum border length determined, the optimum rate of discharge and the corresponding application efficiency can be computed. The optimum rate of discharge is computed from equation [4] using the design value of Y_d, the optimum length the value of B corresponding to Y_d and the optimum length, and the advance time corresponding to Y_d as determined from the accumulative infiltration function.

The application efficiency η is equal to the ratio of the desired uniform volume of application Y_dL to the actual volume of water admitted to the check q_dT.

$$\eta = Y_dL/q_dT \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [6]$$

or

$$\eta = Y_dL/(B+Y_dL) \quad . \quad . \quad . \quad . \quad . \quad . \quad [7]$$

Additional information can be calculated from the data in Fig. 2, including the effect on the application efficiency due to selection of a border length longer than the optimum. For example, if a 0.3-ft irrigation is desired, the value for the application efficiency for the 167-ft border length is 79.4 percent, that for the 250-ft border is 78.1 percent, for the 333-ft border 77.3 percent, 73.2 percent for 500 ft, and an estimated 63.8 percent for the 1,000-ft border. The greater convenience and economy of operation would indicate a 500-ft border would be satisfactory. The discharge rate to be used with this border length is 0.125 cfs per foot unless excessive erosion is expected.

If the solution as obtained gives unsatisfactory efficiency for every economic border length, it may be necessary to modify the design conditions of slope, roughness or puddle factor to get more satisfactory results. For example, presume that a depth of application equal to 0.20 ft had been desired. A border length of 333 ft would give an estimated efficiency of only 54.4 percent. Presuming shorter borders are not economically desirable, it may yet be possible to modify S, n or e to increase the efficiency of a 333-ft border (or whatever other minimum length can be tolerated). The preceding calculation may then be repeated for this length border only, with suitably modified values of S, n and e. In this example, it is desired to reduce intake opportunity time or, what is the same thing, to reduce the time required for the advance to reach a distance L. To accomplish this objective, n and e should be reduced and/or S increased. Since little can be done to control n, either more perfect leveling will be required or the slope should be increased not to exceed erosion limits or economic land-leveling limits.

If, as a further example, a depth of application of 0.500 ft were required in this problem but with a limit on border length of 500 ft maximum, an unsatisfactory situation is again obtained since none of the intersections lie to the right of $Y_o=0.500$. In this example, it would be necessary to increase the time required to reach the end of the check; hence, slope should be decreased and/or the roughness and puddle factor increased as a matter of design. Repeating the calculations for a 500-ft border for new sets of possible values of S, n and e will permit selection of the best values of these parameters.

Some comments are in order concerning B_d and the factor of ignorance f. In this presentation, f was considered to be a constant for a lack of better information. In practice, f can be determined from experience as a function of the other factors affecting the lack of parallel advance and recession curves. It may be noted that the quantity which most affects the "balance" of advance-recession is the distribution of water over the check at time of shutoff.

Summary

The design of a border check can be accomplished based on the infiltration characteristics of the soil and the predicted advance of the wetting front down the check. The former is usually provided by experimental observations, modified as necessary to suit the expected cultural conditions. The latter can be obtained using methods previously outlined (2) or by other suitable means (3), including experimental observations on trial borders. A sufficiently wide range of discharge rates should be used to give a broad picture and to insure that all points of interest will be included.

The procedure permits selection of the optimum border length. It also permits selection of the optimum rate of discharge and the optimum depth of application when the border length is determined. It permits calculation of the probable application efficiency.

When none of the solutions obtained, using most probable values of slope, roughness and unevenness (puddle factor) are acceptable, calculations may be repeated to predict these values of these parameters which might give a more satisfactory solution.

All of the values obtained are limited by other factors not considered here, such as erosion control, salinity control, drainage problems, etc. The solution accepted must be within these limits.

The procedure consists of the following steps:

1 Compute or otherwise obtain a family of advance curves for a number of different rates of discharge in a reasonable range.

2 Compute a volume balance function B (equation [4]) using particular border lengths (e.g., field length and one-half, one-third, one-fourth, etc. thereof).

3 Plot the balance function B as ordinate versus Y_o the depth of application corresponding to an intake opportunity time equal to the time of advance. There will be one curve for each L selected.

4 Estimate the factor of ignorance f (equation [5]) and compute and plot B_d on the same plot as step 3.

5 Determine the intersection nearest to, yet still to the right of the desired depth of application. The border length corresponding to this intersection is the optimum border length.

6 Using the value of B corresponding to the desired depth of application (and its corresponding intake time) calculate the optimum rate of discharge. This must be within an acceptable range.

7 Using equation [7], calculate the application efficiency. If it is unacceptable, repeat steps 1 to 7 for different values of slope, roughness and/or puddle factor as may be

possibly obtained economically. If still too low, alternate irrigation methods should be investigated.

8 If the optimum border length is considered to be too small for economic operation, a check should be made of the probable application efficiency for longer borders at the same depth of application. In many cases, the loss in efficiency may be slight.

Additional experimental research is needed to determine the exact nature of the factor of ignorance f. Treated here as a constant, it is most probably a function of L/q and of the balance between slope, roughness and puddle factor (e.g., $S/(e+n)$ or some similar form). It may be noted that its importance lies primarily in determining the lower limit of $B(Y_o)$. Once a depth of application and length of border is settled upon, the method gives the best discharge rate independent of f, provided only that $B(Y_o) > B_d$. Thus the usefulness of the method is not seriously limited by a lack of knowledge of this factor.

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. . . Logarithmic Sprayer

(Continued from page 438)

gpm at 60 psi; nozzle spacing 13.3 in.; concentrate volume, $v=0.385$ gal; speed, $s=158$ fpm.

From equation [3], "half-distance" $= d_{1/2} =$

$$0.693\left(\frac{0.365}{2.0}\right)158 = 20 \text{ ft}$$

After rearranging equation [4], "application rate" $=$

$$\frac{(2.00)(43560)}{(158)(13.3/12)(4)} = 124 \text{ gal per acre}$$

A convenient method for checking the field performance is to measure the length of plot and quantity of spray applied. Thus, if the flow rate (r) and speed (s) remain constant during the application, the "half-distance" can be checked as follows:

Substitute $(r)\ (t) = g$, gallons sprayed, and let $g_{1/2}$ equal the gallons sprayed to produce a twofold reduction in concentration. Then substituting and rearranging equation [1]

$$g_{1/2} = -2.303v \log_{10}\left(\frac{x}{x_o}\right)$$

$$= -(2.303)(0.365)\log_{10}(0.5) = 0.253 \text{ gal}$$

Since every 0.253 gal sprayed produces a twofold reduction in concentration, then

$$d_{1/2} = \frac{d}{g}[g_{1/2}] = \frac{d}{g}(0.253) \quad . \quad . \quad . \quad . \quad [6]$$

Thus equation [6] can be used directly to check field performance of each application.

TABLE 1. QUANTITATIVE METHOD

Rate of application, drop stand, and weed control at half-dosage distances

Distance, feet	Rate, pounds per acre	Crop stand, percent of check	Weed control, percent of check
0	20	25	99
15	10	79	92
30	5	106	56
45	2.5	98	9
60	1.25	96	0

The test sprayer operated under field conditions as predicted. The evaluation of plots so sprayed presents some new problems. This is primarily because any one rate is represented by an infinitely small area. The plots may be evaluated by either one or both of two methods, quantitative or visual.

In the quantitative method actual counts are taken of both weeds and crop at every half-dosage distance. When the half-dosage distance is 20 ft and one foot is counted on each side of the half-dosage distance, the actual rate will vary from 97 to 106 percent of the designated rate.

The visual method of evaluation measures the distance from the starting point to the point of no crop injury and the point of unsatisfactory weed control. These measurements are converted to the rate of application by means of a graph. The quantitative method yields data that are more reliable because less subject to human error, whereas the visual method pinpoints the critical rates more accurately because it is an evaluation of the entire continuously changing rate rather than an evaluation of only the half-dosage distances. Evaluation by the quantitative method at distances less than half-dosage distances would be too laborious in most cases. Since two methods complement each other, using both is preferred.

The data from a typical application are presented in Tables 1 and 2 and Fig. 6. These data are from a preplant application of CDEC (2-chloroallyl diethyldithiocarbamate) for weed control in field-seeded tomatoes. The herbicide was incorporated two inches into the soil before seeding. The half-dosage distance was 15 ft.

TABLE 2. VISUAL METHOD

Distance and maximum amount of herbicide showing no crop injury; distance and minimum amount of herbicide showing satisfactory weed control (90 percent)

Crop Injury		Weed Control	
Distance, feet	Rate pounds per acre	Distance, feet	Rate, pounds per acre
4	17.5	24	6.8

References

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American Society of Agricultural Engineers

1960 - 1961

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Erosion Characteristics of Rainfall

George R. Free
Member ASAE

Measurements by soil pans of runoff and erosion

MEASUREMENTS of runoff and erosion from field plots under natural rainfall provide information on the complex and varying relationships of rain, soil, water storage, slope and cover. Rarely are any of these, particularly the first three, constant for long. This is certainly true when the soil is exposed to the direct impact of raindrops.

Progress in understanding these relationships will be made along approaches ranging from 100 percent theoretical to 100 percent empirical. Among the many practical objectives will be that of being able to build or design soil conditions in terms of soil physical characteristics and management to meet the stress of design storms without "failure." The term "failure" is used here in the sense of inadequacy for the desired degree of control or deterioration to the point where excessive runoff and erosion occur. The specifications for soil condition and management must be both practical and economically attainable. When compromises are necessary due to limitations of the material at hand, or for other reasons, one should be able to predict the probable point and nature of failure so that supplemental protective measures can be efficiently planned and utilized. Knowledge of what rain does to soil is essential to progress.

The investigation reported in this paper is an outgrowth of previous studies of soil splash reported in 1951 and 1952 (1, 2)*. It was thought that the equipment and methodology previously developed could be used to study the erosion characteristics of natural rain under controlled conditions on a miniature plot scale. The main part of this study extended over a period of five years, 1954 through 1958. Reference is also made here to related studies made in 1950-51.

Certain aspects of studies recently reported by Wischmeier and Smith (8) are closely related to this study. Their work involves analysis of the relationships between rainfall, runoff, and erosion data from runoff plots in many locations. They report an excellent correlation between erosion and the product of energy and maximum 30-min intensity of the rainstorm. This latter term was called the EI variable. The E represents a summation of energy in rainfall based on a relationship of rainfall intensity to drop-size distribution, and hence to kinetic energy. The EI variable was subsequently used by Wischmeier (7) to measure the erosion potential of localized rainfall.

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Ithaca, N. Y., June 1959, on a program arranged by the Soil and Water Division. A contribution from the Eastern Soil and Water Management Research Branch (SWCRD, ARS), USDA, in cooperation with the Cornell University Experiment Station (Cornell Agronomy Department Series Paper No. 500).

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Acknowledgment: The author expresses appreciation to P. L. Manley for valuable help in analyzing rainfall records.

*Numbers in parentheses refer to the appended references.

Fig. 1 Field installation of soil pan

Equipment and Procedures

The equipment used has been described in another publication (1). A photograph and a schematic sketch of the equipment are shown in Figs. 1 and 2. With a water table maintained in the bottom of the soil pan, the test material is near saturation at all times. The elevation of the pans permits loss of soil by splash, but also eliminates the opportunity for return splash as with field plots. Runoff, washoff erosion, and percolation are caught and measured for each storm or series of storms. Since the materials were at or near saturation at all times, "percolation" was essentially equal to "infiltration," and the latter term will be used hereafter without further explanation. At the start of the study, an arbitrary duration of exposure based on amount and intensity of rain was decided upon, but in practice not always observed. However, fresh sand and soil were used for each exposure period. The total loss of soil during a period of exposure can be determined by loss of weight, and the amount of soil lost in splash determined by subtracting washoff loss from the total loss.

During the 1950 study, samples of several New York soils were used as test materials. In 1954 two standard materials were selected for study over a period of years to characterize the erosion aspects of rainfall. One of these

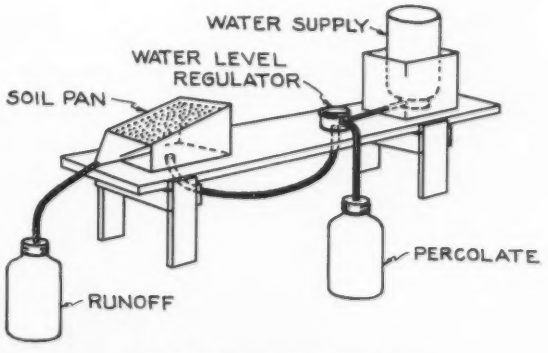

Fig. 2 Schematic sketch of soil pan

TABLE 1. CHARACTERISTICS OF RAINFALL, 1954 - 58 (SUMMARY)

Year	Exposure	Number of exposure periods	Number of storms	Number of runoff records	Amount of rainfall, inches	Maximum intensity (inches per hour) for 15 min	30 min	60 min	Rain at intensity of 1 inch per hour, inches	E* per acre, hundreds foot-tons	EI_{30} †
1954	4/20 - 10/28	13	84	39	15.2	1.5	1.0	0.5	3.7	119.3	61.2
1955	5/4 - 11/16	11	55	38	22.2	2.5	1.6	0.8	4.4	159.8	119.1
1956	5/24 - 10/24	7	78	38	18.0	3.6	2.4	1.7	5.6	130.1	164.9
1957	5/14 - 10/26	11	69	34	17.7	3.1	2.3	1.4	7.6	140.0	134.3
1958	4/25 - 11/3	17	128	54	24.7	2.6	1.4	0.9	5.0	172.1	95.0
		59	414	203	97.8				26.3	721.3	574.5

*Calculated in basis of periods of uniform intensity during individual storms.

†Calculated on basis of individual exposure periods. For exposure periods including more than one storm, this procedure gives higher values of the EI variable than if EI was calculated for individual storms and then totaled for the period. However, a definition of individual storms must always be arbitrary, and since moisture did not vary in this study, there is some justification for considering all rain during an exposure period as one storm and using only one maximum 30-min intensity.

was a standard soil, Honeoye silt loam. The other was a fine to very fine white sand, 98 percent < 250 microns, and 17 percent < 105 microns. The soil represented an aggregated material, and the sand a single-particle material with a range of particle size, but no aggregation.

The amount of rainfall per exposure period ranged from 0.39 to 3.74 in. during fifty-seven of the fifty-nine exposure periods, and for the other two was 5.70 and 7.89 in. All splash pans with treatments in duplicate faced the west. Rainfall amounts and intensities were measured in nearby standard and recording rain gages. The ratio of infiltration to runoff, rather than runoff or infiltration as a percentage of rainfall, was used to describe water relationships.

Summaries of Data

Summaries of data obtained during the five-year period, 1954-58, are presented in Tables 1 and 2. While most of the statistical analyses were made on the basis of fifty-nine exposure periods, these summaries bring out some interesting points. One of these is that storms classed as excessive by U.S. Weather Bureau definition occurred each year, while the maximum intensities did not greatly exceed the five-year expectancies (9).

Washoff losses from both sand and soil were negligible compared with splash losses. Splash losses from sand were between three and four times those from soil. Despite the expected tendency of soil to have greater runoff and less infiltration than sand, measured differences were not great. The over-all ratio of infiltration to runoff was 3.5 for soil, compared to 3.8 for sand. These high over-all ratios indicate relatively fresh soil conditions.

Splash Erosion

Simple linear correlations of splash losses of sand and soil per exposure period with amounts of rain and derived parameters of rain were calculated, and the results are presented in Table 3. The fact that values for the correlations

TABLE 3. VALUES FOR r FOR CORRELATIONS OF SPLASH LOSSES AND RAINFALL

	Values of r for correlation indicated*	
	Sand	Soil
Amount of rain	0.72	0.42
Energy — E	.82	.58
Index — EI_{15}	.68	.65
Index — EI_{30}	.69	.66
Index — EI_{60}	.68	.63

*0.325 — significant at 1 percent level.

of rain and energy with splash losses from sand are higher than those for soil is considered significant. Adding a separate measure of intensity as EI tended to decrease the r values for sand and increase those for soil. The highest r obtained, 0.82, indicates that about two-thirds of the total variability is accounted for by the regression. There was no gain in deviating from the 30-min intensity used by Wischmeier and Smith (8), who were working with washoff erosion losses from field plots under prevailing variations of soil moisture and antecedent rainfall.

The soil and sand splash losses are shown plotted against E on a log-log basis in Fig. 3. The slope of the curves indicates that the splash losses from sand vary as E to the 0.90 power, and from soil as E to the 1.46 power. The dispersion of values around the calculated regression is typical of all plottings of two-factor relationships that were made.

Washoff Erosion

The two storms with highest 30-min intensities for the five-year period caused washoff erosion, and occurred in 1956 and 1957. The only other storm causing washoff erosion occurred in 1955, and ranked among the highest in maximum 5-min intensity, although the 30-min intensity was not outstanding.

A careful study was made of conditions causing washoff erosion from both sand and soil. The first requirement was

TABLE 2. SPLASH PAN LOSSES FROM SOIL AND SAND, 1954 - 58 (SUMMARY)

Year	Number of exposure periods	Total rainfall, inches	Soil (tons per acre)				Water (liters)			
			Splash		Washoff		Runoff		Infiltration	
			Soil	Sand	Soil	Sand	Soil	Sand	Soil	Sand
1954	13	15.2	70.3	260.1	0.0	0.0	3.9	3.9	13.5	13.7
1955	11	22.2	143.1	386.2	0.2	0.0	6.4	5.7	18.5	19.9
1956	7	18.0	64.5	240.5	0.5	0.0	5.0	3.9	15.0	17.1
1957	11	17.7	113.3	323.6	0.2	1.1	4.7	4.3	13.4	16.0
1958	17	24.7	97.8	381.3	0.0	0.0	6.8	5.7	21.7	21.0
	59	97.8	489.0	1,591.7	0.9	1.1	26.8	23.5	82.1	87.7

1.1 liters=1 inch of rain (approximately)

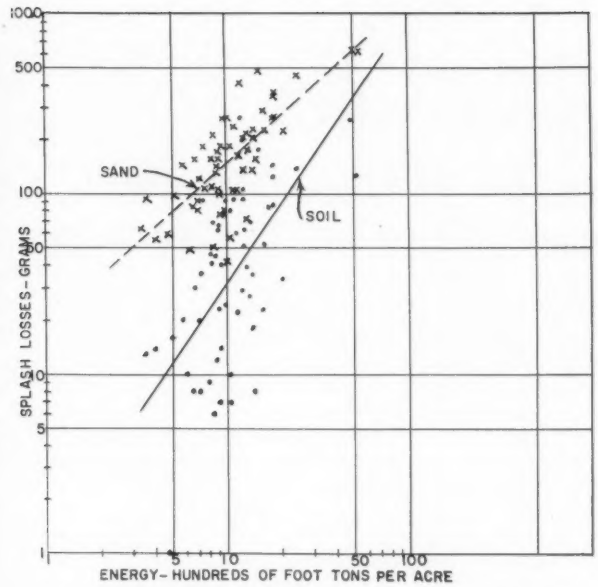

Fig. 3 Relationship of splash losses from soil and sand with rainfall energy

an intensity of 3.25 in. per hour or more with a duration of five minutes or more. The second requirement was antecedent rain with energy amounting to 5.5 hundred foot-tons per acre or more.

High washoff losses occurred from some of the soils used in 1950 and 1951. Splash and washoff losses over the 1950 season from Sassafras silt loam were 54.2 and 5.0 tons per acre, respectively, for two exposure periods and a total rainfall of 12.4 in. Corresponding losses for Dunkirk silty clay loam were 128.0 and 11.2 tons; for Honeoye silt loam, 57.4 and 0.3 tons; and for Ottawa fine sandy loam, 102.2 and 0.5 tons. In 1951, with one exposure period and 9.4 in. of rain, losses from Honeoye were 64.9 and 1.5, compared to 36.7 and 5.1 from Sassafras, the only soils studied. Both the Dunkirk and Sassafras soil are considered highly erodible. Based on field runoff plot data, Musgrave (6) reported that this Dunkirk soil was about three times as erodible as the Honeoye. The splash pan technique compares only surface soils, and not profiles as they occur in the field.

Ratios of Infiltration to Runoff

The relationship of ratios of infiltration to runoff with energy for both sand and soil were hyperbolic in nature. A regression curve for sand (Fig. 4) was computed on the basis of log-log transformations in which the exponent of E was found to be -0.4. Because of the wide dispersion of a few values, even this transformation of data did not provide a statistically significant relationship for soil, although a curve similar to that for sand seemed to be indicated. Values of the ratios decreased rapidly up to an E value of about 8.5 hundred foot-tons.

A study was made of variations in infiltration to runoff ratios within exposure periods where there had been two or more records. These data indicated a more rapid decrease of infiltration capacity for soil than for sand.

That soils differ greatly in initial and final infiltration to runoff ratios is shown by data obtained during 1950 and 1951 (erosion data cited previously under "Washoff Erosion"). In the first 1950 period for an initial large storm of 2.4-in. ratios for Sassafras and Dunkirk were 0.33 and 0.27, respectively, compared to > 1.61 and 2.58 for Honeoye and Ottawa, respectively. Some amount of percolate for the last two soils was lost. After about five inches of rain, ratios in the same order were 0.19, 0.15, 0.45, and 0.54.

Discussion of Results

The data indicate that movement or removal by splash is by no means a satisfactory indicator of susceptibility to washoff erosion. Possibly one of the most significant findings in this study is the paucity of washoff erosion records for the period of study using the standard sand and standard Honeoye soil. One of the probable reasons for this is that there was little opportunity for concentration of water into rivulet or channel flow with the resulting higher velocity necessary for transport. Also, much of the material loosened by raindrop impact was removed in splash which prevented its transport in the runoff to become part of washoff erosion. The effect of removal of soil in splash needs further study, and the reader is referred to (1, 5) and to an unpublished thesis†.

The decrease of ratios of infiltration to runoff for soils with any degree of aggregation can be partly attributed to breakdown of aggregates. A similar decrease in ratios of infiltration to runoff for the standard sand cannot be explained in these terms, but does place considerable emphasis on sealing and compaction of the surface.

From the standpoint of soil data that might be useful for "design" purposes, the energy value of 8.5 hundred foot-tons per acre is of interest. It was associated in this study with a marked change of ratios of infiltration to runoff, while a value only slightly less was associated with the occurrence of washoff losses. *(Continued on page 455)*

†Thesis entitled "An Evaluation of Soil Splash as a Factor in Soil Erosion."

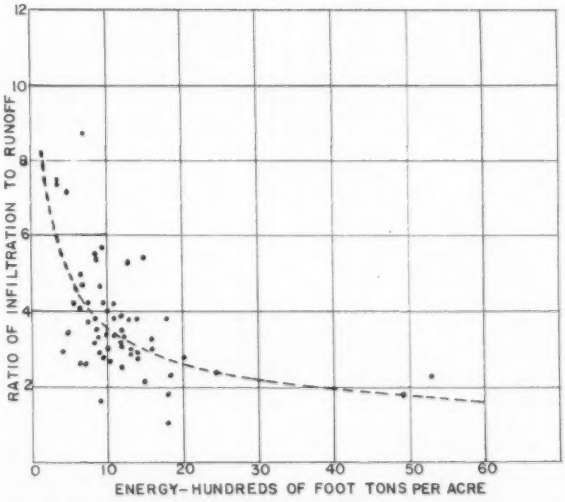

Fig. 4 Relationship of ratios of infiltration to runoff for sand with rainfall energy

Modification of Bridge Controls to Simulate Diurnal Cyclic Variation of Temperature, Humidity, and Radiation

Richard A. Schleusener
Assoc. Member ASAE

Larry G. King
Assoc. Member ASAE

AN environmental control chamber in which temperature, humidity, and radiation can be controlled has been constructed in connection with a study of evaporation from soils*. The experiments established a need for cyclic variation of temperature, humidity, and radiation to simulate the diurnal variation of these meteorological parameters.

The details of the system devised to accomplish this objective are described in this paper. Similar arrangements may be used in a variety of applications employing a bridge circuit.

For maintaining steady temperature in the chamber, the controls consisted of a temperature sensitive element located in the return duct and connected into a resistance bridge circuit. A change in temperature at the element produced a change in its resistance, unbalancing the bridge circuit and creating a voltage signal. This voltage signal was amplified to operate a relay which in turn operated the proper corrective mechanism to adjust the temperature within the chamber so as to bring the bridge back into balance. The controls for maintaining a steady condition of relative humidity operated in a similar manner.

In order to produce cyclic variations, an unbalance was introduced on one leg of each bridge at appropriately timed intervals. Timing and control for the system was provided by a timer giving an impulse every 72 min (1/20 of a 24-hr day) to an eight-bank, twenty-position stepping relay. The desired diurnal cycles of ambient conditions are shown in Fig. 1, the dashed lines of which show the stepwise variations that approximated the desired curves.

Fig. 2 shows the arrangement used to accomplish the desired stepwise variation in temperature and humidity, also the details for turning on and off various combinations of heat lamps *(g)* for simulating radiant energy from the sun.

On the stepping relay, banks m_1 to m_4 control the timed sequence of heat lamps to simulate radiant energy. Bank m_5 is not used. Banks m_6 and m_7 are used to program the variation in temperature. Fig. 2 shows, for example, that when the stepping relay is in position 1-3, and 19 and 20, the potentiometers *(h)* are bypassed, and the bridge operates the same as under steady-state conditions. For other positions of the stepping relay, additional resistances *(h)* are added to one leg of the bridge, thereby producing an unbalance which results in a temperature change within the chamber until the temperature bridge is brought into balance with the added resistance of the potentiometers *(h)*.

Bank m_8 is used in a manner comparable to banks m_6 and m_7 to add varying amounts of resistance to one leg of the relative humidity control bridge for positions other than 1 to 6 and 20 of the stepping relay.

Fig. 3 shows the timer, rectifier, stepping relay, and resistance units used to accomplish the modification to produce cyclic conditions within the environmental control chamber.

Fig. 4 shows a typical weekly record from a recording hygrothermograph located inside the chamber. The degree to which the equipment is successful in producing the desired cyclic variation in temperature and humidity can be seen by comparing Fig. 4 with Fig. 1.

The amplitude of the variations of temperature or humidity can be changed by adjustment of the potentiometers *(h)* or the adjustable resistor *(i)*. The range within which the equipment operates for a fixed amplitude can be set using the control point adjustment on each bridge.

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The authors — R. A. SCHLEUSENER and L. G. KING — are, respectively, assistant research engineer and graduate research assistant, civil engineering section, Colorado State University, Fort Collins.

*Colorado contributing project to Western Regional Project W-32 concerning basic hydrologic factors relating to water conservation.

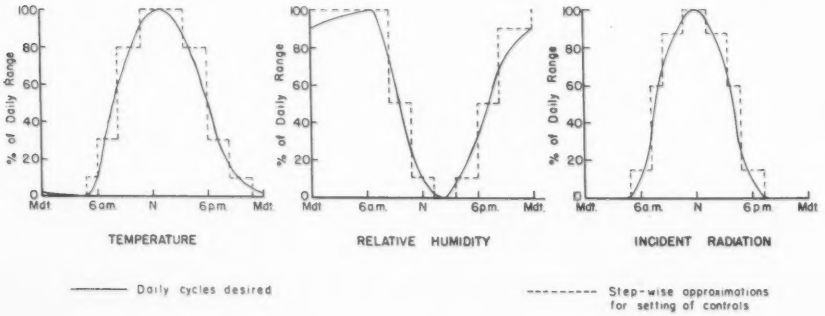

Fig. 1 Diurnal cycles of ambient conditions in environmental control chamber

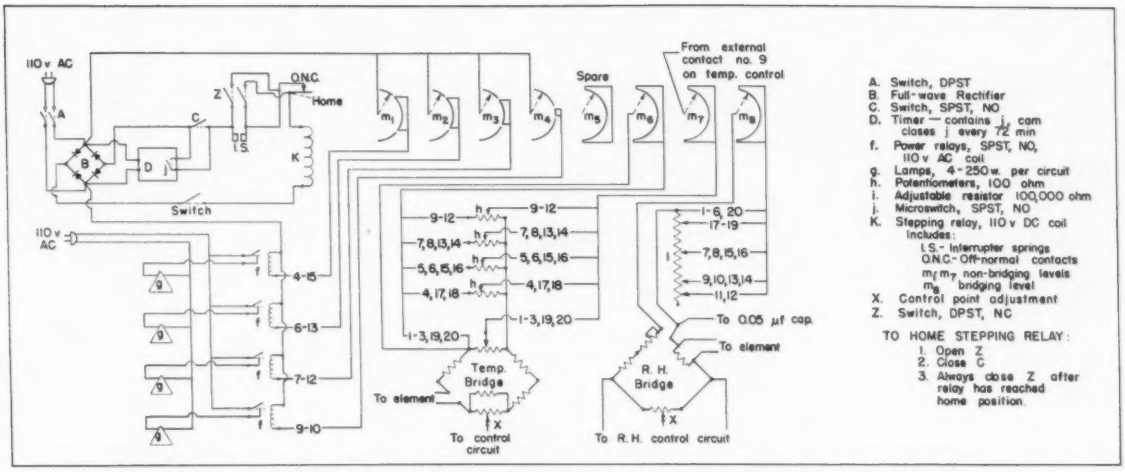

Fig. 2 Circuit for cyclic control of ambient conditions of temperature, humidity, and radiation

The stepwise variations which appear in Fig. 4 could be smoothed by the addition of a greater number of control points within the 24-hour period. This would require a stepping relay having more than twenty positions and a greater number of resistance units.

The performance of the equipment is considered adequate to accomplish acceptable diurnal cyclic variation of temperature, humidity, and radiation. The equipment has been operating in a satisfactory manner for about eighteen months.

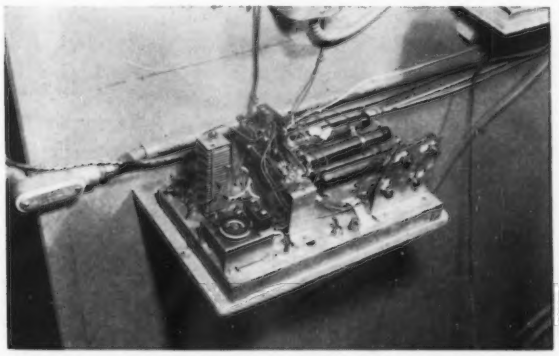

Fig. 3 View of timer, stepping relay and associated equipment used to produce cyclic variation of ambient conditions

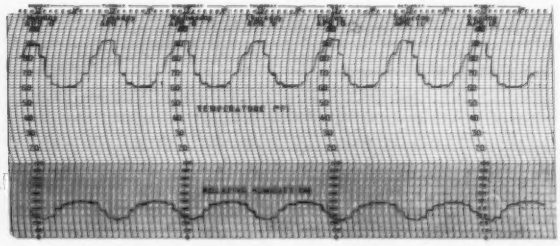

Fig. 4 Hygro-thermograph record showing diurnal cycles of temperature and humidity produced in environmental control chamber

Continued Education for Engineers Featured in ASEE, Agricultural Engineering Division Program

THREE phases of continued education were given attention when the Agricultural Engineering Division of the American Society for Engineering Education met at Purdue University, June 20.

"What Industry is Doing for Continued Education of Engineers" was the opening contribution, by E. F. Schneider, vice-president, International Harvester Co. R. R. Raney, director of engineering, New Idea Division, Avco Corp., followed with a discussion on the subject. Both noted the high participation of engineers in technical training made available by employers, and also in broader training for management responsibilities.

Industry seminars for teachers and advanced professional students, as provided for several years by the Farm Equipment Institute and several of its leading member companies, received special emphasis. This was in the treatment of "Continued Education for Teachers by Industrial Contacts" by Bill A. Stout, assistant professor of agricultural engineering, Michigan State University, and discussion by G. W. Isaacs, associate professor of agricultural engineering, Purdue University.

The most controversial subject on the program proved to be "Continued Education for Teachers by Active Research." C. G. E. Downing, head of the engineering science department at Ontario Agricultural College presented a case for research as an intellectual stimulant for teachers, and a means of helping them keep up to date in their technology. Discussion by T. W. Edminster, assistant chief, Soil and Water Conservation Research Branch, Agricultural Research Service, USDA, represented the viewpoint of an administrator of research. He raised material questions on work efficiency in dual assignments, and the danger of either research or teaching receiving major attention at the expense of the other, depending on the primary interest of the individual with daily duties in both fields.

A luncheon and business meeting followed the formal program, with E. T. Swink, division chairman, presiding. During the meeting a proposal was approved to have a constitution and by-laws governing the divisions' operations drafted and presented to the Division members for action by letter ballot.

George E. Spencer, chairman of the nominating committee offered a single slate of nominees, including, for chairman, A. W. Farrall; vice-chairman, J. B. Liljedahl; secretary, R. A. Palmer; editor, H. L. Wakeland; and representative on the general council of ASEE, F. B. Lanham. All were elected.

Following a brief conference of the new executive committee, Chairman Farrall designated B. F. Parker to serve as program chairman for the next annual meeting, at Lexington, Ky., June 26-30, 1961.

Later in the week at a Conference on "Educational Programs of Some Professional Engineering Societies," sponsored by the General Council and appropriate divisions, Chairman Farrall was the opening panelist, reporting on the educational program of ASAE.

As an institutional member of ASEE, the American Society of Agricultural Engineers was also represented in activities of the Engineering College Administrative Council by F. B. Lanham; and in activities of the Engineering College Research Council by G. W. Isaacs.

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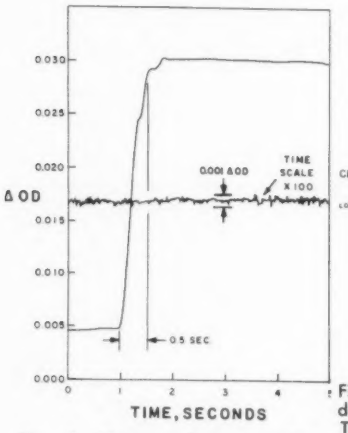

Fig. 6 Noise and response-time curves of the dual-monochromator spectrophotometer

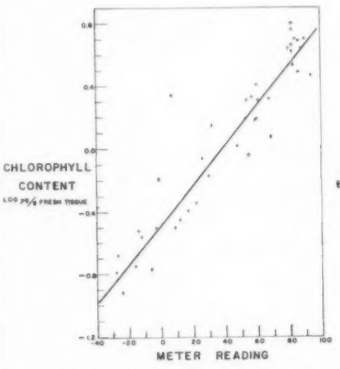

Fig. 7 Chlorophyll calibration of the dual-monochromator spectrophotometer. The meter reading indicates ΔOD (695-725) with full scale on the meter equal to about 0.77 ΔOD

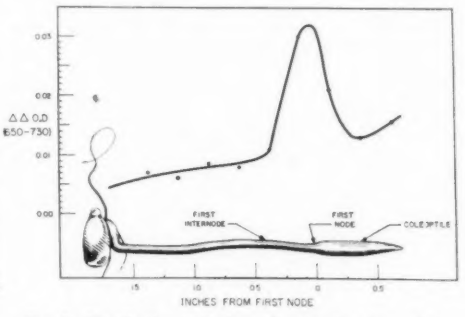

Fig. 8 Distribution of the photoresponsive pigment in 2½-in. corn seedlings

Another application of the instrument was to study a photoresponsive pigment which controls developmental processes such as elongation, color, flowering and germination in certain plants. Physiological work has indicated the pigment exists in two interconvertible forms (5). The form of the pigment depends upon the nature of the illumination on the plant. Butler *et al* (8) demonstrated the presence of the photoresponsive pigment spectrally. The procedure followed to indicate the presence of the pigment is to illuminate a sample of tissue with red light and measure the ΔOD (650-730). The change in this measurement caused by subsequent illumination with far-red light is assumed to be proportional to the amount of photoresponsive pigment present in the tissue and is denoted as $\Delta\Delta OD$ (650-730).

Fig. 8 shows the distribution of the photoresponsive pigment in corn seedlings. The curve is based upon examination of a series of composite 2-gram samples. Each sample was made up of ¼-in. segments of tissue taken from the same position (with reference to the first node) of several 2½-in. seedlings. Although the shape of the curve above the coleoptile is based on only three points, the curve was substantiated by additional observations. The maximum concentration of the photoresponsive pigment occurs just below the first node. This corresponds with the area of greatest growth activity in young corn seedlings.

Summary

A dual-monochromator spectrophotometer capable of measuring optical density of a sample at any two wave lengths in the visible region and computing the optical-density difference (ΔOD) is described. The instrument is suitable for measuring optical-density differences of intact agricultural products. It has noise and sensitivity such that an optical density change of 0.001 can be detected. The response speed is 0.5 sec for 90 percent full scale. The meter reading vs. ΔOD is nearly linear with a ΔOD of 1.5 or less, full scale. The instrument has been used to indicate the chlorophyll content ot intact peaches. The correlation coefficient between chlorophyll content of peaches and the chlorophyll content indicated by the instrument is 0.939. Another use of the instrument has been to study a photoresponsive pigment found in minute amounts in plant tissue. The maximum concentration of the pigment in young corn seedlings as determined with the dual-monochromator spectrophotometer appears to occur just below the first node in the region of greatest growth activity.

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(Continued from page 431)

moisture contents of 12, 16, and 20 percent. The maximum emergence energy was obtained for a moisture content of 20 percent, drying time of 16 days, and surface compaction pressure of 16 psi. Under these conditions, the surface layer developed the greatest mechanical strength. This provided evidence that the drying of the surface soil is one of the factors responsible for the development of mechanical strength. Development of mechanical strength also depends upon soil compaction, soil type, and initial soil moisture content at time of compaction.

Bulk density of the soil at moisture contents of 12, 16, and 20 percent increased with compaction pressure as shown in Table 4. The maximum value was obtained for a moisture content of 20 percent and compaction pressure of 16 psi. The energy required for emergence of the mechanical seedling increased with bulk density.

TABLE 4. BULK DENSITIES FOR BROOKSTON SANDY LOAM SOIL AT VARIOUS MOISTURE CONTENTS AND COMPACTION PRESSURES

	Initial Soil Moisture Content (Percent)		
Surface compaction pressure	12	16	20
psi	Grams per cubic centimeter		
1	0.938	0.925	0.981
½	0.893	0.848	0.886
2	0.994	0.943	1.020
4	1.040	1.043	1.120
8	1.110	1.110	1.230
16	1.116	1.153	1.300

Effect of Soil Aging on the Force and Energy Required for Emergence. A laboratory experiment was conducted at a soil moisture content of 16 percent in which the soil sample boxes were sealed to prevent loss of moisture. Compaction pressures of ½, 1, 2, 4, 8, and 16 psi were applied to the soil surface. A mechanical seedling (tip diameter, 0.078 in.) was forced through the boxes immediately after they were prepared and 1, 2, 4, 8, 16, and 32 days later.

In contrast to the marked increase in the emergence energy required as the soil dries, Fig. 9 indicates that energy required for emergence increased little with aging when soil moisture was held constant. The energy required for emergence tended to increase slightly with aging at the higher compaction pressures. This increase might be explained by a small loss of moisture from the test boxes. The theory has been advocated that soils behave like concrete (1); the longer they age, the stronger they become. The results of this experiment indicate that any increase in hardness of the soil under non-drying conditions may be due to a slight moisture loss and/or aging of the soil.

Fig. 10 compares the emergence energy under drying and non-drying (sealed boxes) conditions. The large increases in emergence energy were due to the drying of the surface layer of soil. For 16 days aging, the ratio of emergence energies on non-drying to drying conditions was 5 to 1. This suggests that a method of covering the seedbed after planting should be developed as a means of reducing the energy required for emergence of seedling plants.

Effect of Compaction Pressure Applied at Seed Level on the Force and Energy Required for Emergence. Compaction pressures of ½, 1, 2, 4, 8, and 16 psi were applied at a 1-in. depth (seed level) in the sample boxes. A compaction pressure of ½ psi was applied to the surface. The initial soil moisture content was 16 percent. A mechanical seedling (tip diameter, 0.078 in.) was forced through the test samples immediately after they were prepared and 1, 2, 4, 8, and 16 days later.

The emergence energy increased with drying time and compaction pressure, but the maximum increase was less in this treatment than when similar compaction pressures were applied at the surface (Fig. 11). (See comparison in Fig. 12.) When the pressure was applied at seed level, a considerably smaller increase in rate and total energy was required for emergence under drying conditions.

Stout (7) obtained greater seedling emergence of corn, beans, and sugar beets by applying the compacting pressure at seed level than for applying the same pressure at the soil surface. This can be explained by the data obtained in this experiment. With compaction pressure applied at seed level and loose soil covering the seed, the development of mechanical strength in the surface layer was retarded and less energy was required for emergence.

Fig. 13 is a drawing of the force versus depth curves traced on the oscillograph as the mechanical seedling

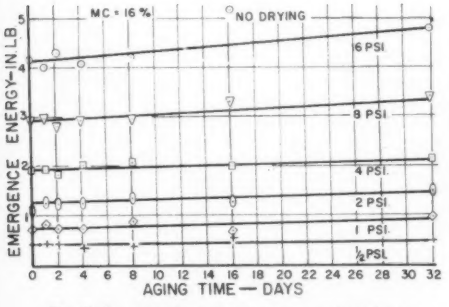

Fig. 9 Emergence energy versus aging time for surface-compaction pressures of ½, 1, 2, 4, 8, and 16 psi. Soil moisture content maintained at 16 percent

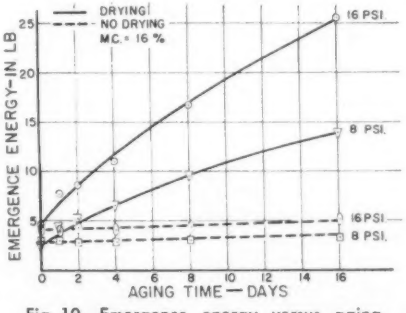

Fig. 10 Emergence energy versus aging time for compaction pressures of 8 and 16 psi. Solid line, drying condition. Broken line, non-drying condition. Initial soil moisture content, 16 percent

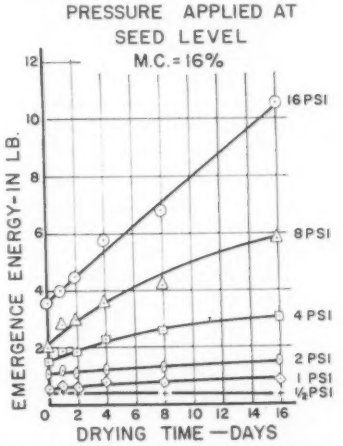

Fig. 11 Emergence energy versus drying time for compaction pressures of ½, 1, 2, 4, 8, and 16 psi applied 1 in. below the soil surface followed by ½ psi applied at the surface. Initial soil moisture content, 16 percent

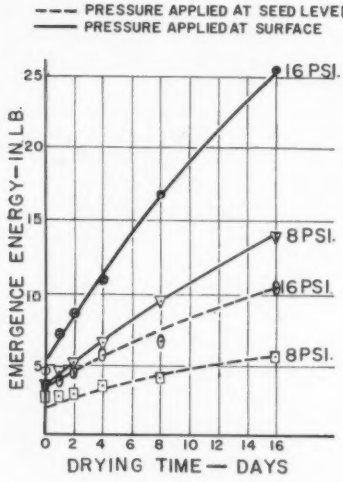

Fig. 12 *(left)* Emergence energy versus drying time for compaction pressures of 8 and 16 psi. Solid line, pressure applied at the surface. Broken line, pressure applied 1 in. below the soil surface. Initial soil moisture content, 16 percent

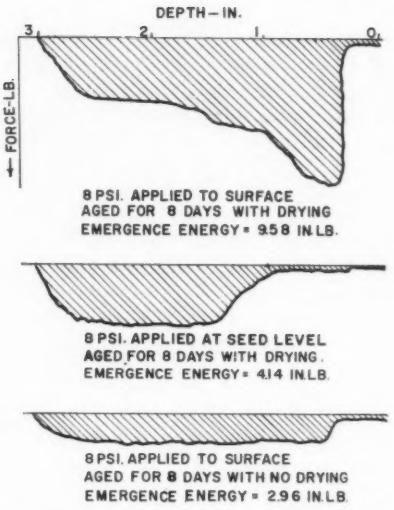
DEPTH—IN.
3 2 1 0
FORCE-LB.
8 PSI. APPLIED TO SURFACE
AGED FOR 8 DAYS WITH DRYING
EMERGENCE ENERGY = 9.58 IN.LB.
8 PSI. APPLIED AT SEED LEVEL
AGED FOR 8 DAYS WITH DRYING.
EMERGENCE ENERGY = 4.14 IN.LB.
8 PSI. APPLIED TO SURFACE
AGED FOR 8 DAYS WITH NO DRYING
EMERGENCE ENERGY = 2.96 IN.LB.

Fig. 13 *(right)* Force versus depth diagrams for the conditions stated

emerged through a 3-in. depth of soil for the conditions listed below each graph. A detailed analysis of the oscillograph charts shown in Fig. 13 follows:

1 Compaction pressure applied at the surface. As the mechanical seedling enters the bottom of the 3-in.-thick layer of soil, the force increases rapidly at first and then tends to remain constant until a depth of 2 in. At this point the force tends to increase gradually until the 1-in. depth is reached. Between a depth of 1 and ⅜ in., the emergence force approximately doubled due to the hard compacted layer caused by surface drying. The inverted soil cone above the mechanical seedling tip sheared from the soil mass at a depth of approximately ⅜ in., as can be seen by the sudden drop in force.

2 Compaction pressure applied at seed level. The emergence force approached a maximum at a depth of approximately 2½ in. and remained constant until a depth of 1 in. was reached. At this point the emergence force decreased rapidly to a constant value between the 1-in. depth and point of shear. A very large decrease in the emergence energy is evident.

3 Pressure applied at the surface with no drying. The emergence force increased to a maximum value and remained essentially constant to the point of shear.

Table 5 presents representative values of the emergence energy for the 1, 2, and 3-in. planting depths. The percent reduction in emergence energy is presented for *(a)* compaction pressure applied at the surface under non-drying conditions and *(b)* compaction pressure applied at seed level under drying conditions. These are compared to compaction pressure applied at the surface under drying conditions (conventional method of planting).

A considerable reduction in the energy required for emergence of the mechanical seedling was realized by applying the compaction pressure at seed level and preventing drying of the soil surface. A much greater reduction in the emergence energy for the 1 and 2-in. planting depths is evident as compared to a 3-in. planting depth.

Since the energy required for emergence increased markedly with increasing compaction pressure at the soil surface and with length of drying period, several methods for reducing the emergence energy required of plant seedlings are visualized as follows:

1 Decrease or eliminate compaction pressure at the soil surface but apply the pressure at seed level. This will reduce the mechanical strength of the surface layer of soil.

2 A shallow depth of planting will require less energy for emergence and shorten the period of time between planting and emergence of a seedling. In general, the faster the emergence, the lower the energy requirement.

3 Prevent the soil surface from developing mechanical strength by covering the seedbed.

4 Design a soil profile to eliminate the crusting problem and reduce emergence energy. (This might be some form of ridge.)

5 Provide a firm underfooting for the seedling to prevent it from shearing from the roots while developing the force necessary to overcome the mechanical impedance of the soil.

6 Prevent soils from developing mechanical strength when they dry with some type of chemical additive.

7 Develop means of keeping the soil surface moist thus preventing the soil from drying out and increasing the energy required for emergence.

8 Plant soaked seeds that have taken up sufficient moisture for germination, thus increasing the speed of emergence and decreasing the emergence energy.

Summary

A penetrometer was designed, developed and fabricated that measured relative emergence energy requirements of

TABLE 5. EMERGENCE ENERGY FOR VARIOUS PLANTING DEPTHS AND SEEDBED CONDITIONS

Planting depth	Emergenc Energy			Percent Reduction*	
	Surface compaction, drying	Surface compaction, non-drying	Seed level compaction, drying	Surface compaction, non-drying	Seed level compaction, drying
in.	in.-lb	in.-lb	in.-lb	percent	percent
1	3.71	0.82	0.02	78	99
2	6.80	2.02	2.04	70	70
3	9.58	2.96	4.14	69	57

*Percent reduction as compared to surface-compaction pressure under a drying condition.

plant seedlings. Basic information concerning the seed environment for maximum emergence of plant seedlings was collected in a series of laboratory experiments. Data obtained in this study shows that the emergence-energy requirements increased directly with soil-compaction pressure, initial soil-moisture content, depth of planting, amount of surface drying, and indirectly with moisture content at time of measurement. As the seedling diameter increased, the emergence energy increased. Thus, a bean seedling would require more energy for emergence than a corn seedling. Applying compaction pressure at the seed level and preventing evaporation from the soil surface reduced the emergence energy.

The results of this study indicate that planters for corn, beans, sugar beets, etc., should be designed to press the seed into moist soil and then cover with loose soil for maximum seedling emergence.

Several methods of reducing the energy required for emergence of plant seedlings were suggested.

Conclusions

1 The energy required for emergence increased directly with compaction pressure, initial soil moisture content, amount of soil-surface drying, and indirectly with moisture content at time of measurement.

2 When the soil was permitted to dry, a marked reduction in the emergence energy was realized for various planting depths by applying the compacting pressure at seed level as compared to applying the compacting pressure at the soil surface.

3 When the soil moisture was held constant by preventing evaporation, the mechanical strength of the soil surface increased only slightly with aging. For various planting depths, the energy required for emergence of the mechanical seedling was reduced markedly as compared to a drying condition.

4 Depth of shearing position of the inverted cone below the soil surface was independent of surface-compaction pressure at constant soil moisture and tended to increase slightly when the surface was subjected to drying.

5 Energy required for emergence and depth of shearing below the soil surface increased with the mechanical seedling diameter.

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. . . Erosion Characteristics

(Continued from page 449)

Using a value of 8.5, it is only necessary to assume the depth affected to be about one-tenth inch to arrive at a value of 65 ft-lb of energy per pound of soil. This is the same order of magnitude as the 51 ft-lb per pound used on Honeoye soil by Free *et al* (3) in an entirely different study concerned with soil permeability and mechanically applied energy. It is also of the same order of magnitude as a typical value of 1705 ergs per milligram (57 ft-lb per pound) reported by McCalla (4) as the energy required to break down topsoil aggregates. This similarity of energy values can hardly be regarded as accidental.

Summary

Small pans of a standard soil and a standard sand at constant high levels of moisture were exposed to natural rainfall for 59 exposure periods from 1954 through 1958. The relationships between splash erosion losses for both materials with calculated energy values for rainfall were exponential and of the parabolic type. Splash losses from sand, totaling nearly 1600 tons per acre for the 5-year period, were more than three times those from soil.

There were only three storms during the 5-year period when washoff losses of sand or soil occurred. Totals for the 5-year period for either sand or soil were about one ton per acre. High intensity rain of appreciable time duration combined with some packing and sealing by antecedent rainfall were required before sand or soil was removed in runoff from these small areas.

The relationship of ratios of infiltration to runoff for both materials with calculated energy values for rainfall were exponential and of the hyperbolic type. Although over-all values of ratios for sand and soil were similar, those for soil tended to decrease more rapidly with increasing amounts of energy than those for the sand.

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. . . Extending Our Horizons

(Continued from page 427)

Michigan State and will cooperate with the department of agricultural engineering in giving Food Engineering training. Dr. Farrall served as acting chairman of this program until the new department was set up. Currently, Michigan State is offering a food engineering option in its agricultural engineering curriculum.

This work is now being extended at the University of Massachusetts, where Dr. R. W. Kleis is setting up a curriculum in agricultural and food engineering. Also, at the Davis campus of the University of California, Dr. Roy Bainer, who was president of our Society three years ago, is setting up an entire new engineering program which includes a curriculum in food engineering.

At a number of our ASAE section meetings during the past year, I have mentioned this significant development and the possible tremendous effect it could have on the future of our profession and our society. When the many advances of recent years are considered, it is easy to envision the future development of agricultural processes to the point where they would not be conducted either in the field or elsewhere on the farm a few decades hence. This horizon could even be extended to the point where the remaining biological processes involved might all be conducted not only under roof but also under completely controlled conditions—or with vats replacing fields and specialized single-cell organisms replacing plants and animals as we now know them. However, if we develop skilled engineers for the closely related fields of food processing and technology, we can rely on them to lead our profession into an era when production of crops, as we now consider them, might be needed only to produce some of the carbohydrates and related raw materials for the biochemical processes which would in turn provide our food and clothing.

Keeping alert to the economic factors involved as we think of pushing out beyond present horizons, there is another important aspect of food processing which should not be overlooked. The value of farm products as delivered to American housewives has a value of approximately 90 billions of dollars, which is almost three times the amount which the farmer receives for his total production. In view of this, food processing of itself could develop about twice the scope for application of engineering effort than we now have in food production.

One of the related groups with whom I met during the past year was the Northeast Farm Management Research Committee. In the discussion following my prepared remarks, I found this group of agricultural economists, specializing in farm management research, to be keenly alert to the current needs of agriculture and to possess full cognizance of the importance of agricultural-engineering efforts in this field. Therefore, I took occasion to discuss with them my personal opinion that agricultural engineering should play a much more important part in the farm management picture, to the extent possibly of taking over this entire field from the area of agricultural economics with which it is now more closely identified. Rather surprisingly my comments were taken kindly and this served to strengthen my conviction that our profession should push out in this direction.

Looking further into the future, it will be of utmost importance that we keep pace with the advances of science. The recent emphasis of science on the problems of space travel seems about as far from agricultural engineering as one can get, both literally and figuratively. However, the findings of current space research could have a profound effect on the future of our profession and on agriculture itself. Space travel will involve complete environmental control, which means providing all life-sustaining materials for an isolated individual or small group. And in the light of all this, let us not forget that the farmer is presently our most isolated person and he comprises a major segment of our population.

Significant examples of things being developed in the current space research and related programs include highly efficient heat pumps and exchangers, highly dependable automatic controls, effective separation of aqueous solutions beyond anything presently practiced, and economical generation of electric power directly from sunlight and from fuels. All this is being done in highly efficient portable, individual units.

These developments can change the entire present concepts of farm power requirements, of supplies of electricity; of farm processing operations; of mechanical, electrical or hydraulic controls; of availability and distribution of water; of waste disposal; and even of weather control and management. To keep abreast of these significant new developments of science means that we must greatly extend our professional horizons if we are to continue serving the needs of agriculture effectively.

The foregoing examples from the glamorous field of space research are indeed important, but we must not let their great possible future potential overshadow other research work currently being done. The improvements being made daily by plant breeders, the current findings of the animal science researchers which have immediate application, the better materials being developed in other fields which can be adapted to farm use, the design improvements being made constantly by our agricultural engineers — all these are vital also. Since they fall within our present horizons, they are specially important and urgently demand our first attention.

Looking about us more closely, other horizons become apparent. Sometimes we allow ourselves to be hemmed in by the walls of prejudice, and again we have our thinking obstructed by fixed thought patterns, and often bound by the walls of habit. Dr. Hans Selye in a magazine article on basic research gives the example of scientists and laboratory workers who had known for many years that cultures of microbes would be spoiled if exposed to mold. This they saw, but they did not perceive the significance of the observation and their only conclusion was that cultures of germs and bacteria must be protected from molds. This becomes even more inconceivable when we realize that these cultures were being raised primarily to find out what methods or substances could be used to kill germs! It remained for Alexander Fleming to perceive that, if molds inhibit cultures, then molds must produce substances that kill microbes, and thus he made the important discovery of penicillin.

In Indiana, Mr. Tillman Bubenzer, the manager of Connor Prairie Farms learned of a report from England that sheep gained better and more efficiently when fed small amounts of feed every few hours around the clock. His farms were getting into the beef business and he reasoned that the bovine's ruminant type of digestive system was like that of a sheep and therefore this finding should also apply to beef cattle. So he wrote to all the leading animal husbandry schools but found only two that had any knowledge of this work, and neither of them had done any research in this area.

Later I became interested in this development and personally talked with an older research man. I can still picture his look of disdain as he commented on the idea of fattening cattle on anything but "full feed". From my recollection of the attitudes of most of the animal husbandry professors at my alma mater when I attended, this reaction was quite familiar. Those men worshipped at the tankbark altar of the show ring and their shrine was the arena at the International Livestock Exposition!

How refreshing it was to return to Iowa State University last fall and discuss this matter with the present staff of the animal science department. Dr. Walter R. Woods, a young researcher probing in this field, thought it entirely possible that maintenance of digestion and metabolism, at a relatively constant level with ruminant animals, could show promise of higher feed-conversion ratios. Meanwhile preliminary results at Illinois are starting to bear out this theory.

This so impressed me that I decided to give the system a trial with the small Angus cattle operation on which I have been losing money for the past several years. As yet I am not far enough along to learn anything about feed-conversion ratios, but I did make a few observations that are pertinent here.

To feed each steer limited amounts at regular intervals means he must be kept in a stall, much like a dairy cow. In designing the barn floor for this operation, I decided to provide plenty of capacity for the manure, and so made the gutters wide and deep. Before completing the stalls, we put a few animals ranging from a 450-lb calf to a 1100-lb bull in the first stalls to check our design and dimensions.

Though they were tranquilized beforehand I noticed the animals all hesitated to cross that deep gutter, some feeling tentatively into it with one foot, but all, in the end, leaping completely across and into their stalls when prodded. Only the bull fought his tie collar strenuously, but even he settled down in less than a half day.

After a few days of confinement, they were as contented as any animals I have ever

seen. In fact, one steer with a rather small head started slipping off his collar every night, but never left the stall. So we left it off and he stayed untied in his 3-by-5½-ft stall for several weeks. But the real revelation came when we started to move these animals over to the new stalls so that we could rework the first group to the "improved" dimensons indicated by the trial. Not an animal could be forced to back down into the gutter to leave its stall. After an hour's effort and finally bridging the gutter, the steers had to be whipped and pushed to make them leave their stalls.

Let us not become so comfortable in our little stalls of habit, in our narrow cubicles of special learning, in our familiar thought patterns—nor so hemmed in by a gutter of ignorance which we don't have the courage to investigate—that we also become content to spend the rest of our days in such captivity. Rather, let us remain alert and continue striving to see and to experience what lies beyond the pale!

Looking back a moment to the past, it is of interest to recall that during earlier stages of development in most areas of human endeavor, stress was laid on the brilliant efforts of individuals rather than of groups. In government we had kings and rulers; in industry and commerce, the rugged individualists, and in developing new products and methods, we relied on the efforts of lone inventors. The history of our profession has also been marked by the brilliant accomplishments of the individual rather than the broadly executed programs of the many. In the fields, where we are concerned, this is changing to group efforts of organized, coordinated teams of workers who pool knowledge, effort and resources to accomplish desired objectives. Indications are that this trend will continue, so in the future we will be much more concerned with effective efforts of groups, including those of other professions and fields of science. Not that we should ignore or detract from the intensive efforts and the creative abilities of a gifted and dedicated individual. Rather the aim should be to multiply his effectiveness by acting in coordinated relationship with others, when this proves feasible.

This might well mean changing some of our educational processes. To get men to work together most efficiently, perhaps each individual should be educated in the manner that best suits his particular potentials. Remembering that there are also horizons behind us, a few excerpts from Edith Hamilton's "The Lessons of the Past", published also in that thought-provoking little volume "Adventures of the Mind", may be pertinent here: "Geniuses are not produced by spending money. We need the challenge of the way the Greeks were educated. They fixed their eyes on the individual. We contemplate millions" . . . "The Athenians in their dangerous world needed to be a nation of independent men who could take responsibility, and they taught their children accordingly." Yet we know that the Greeks learned to work together effectively to achieve the highest civilization then known and perhaps the most perfect democracy the world has ever seen.

Also worthy of note during our period of history is a further quotation from the source just quoted: "When the Athenians finally wanted not to give to the state, but the state to give to them, when the freedom they wished most for was freedom from responsibility, then Athens ceased to be free and was never free again. Is that not a challenge?"

The advances of American agriculture due to applications of new findings of science are also impressive. As a profession that has undertaken responsibility for application of that knowledge, we are placed in a central, coordinating position. To be effective, either while in the present stage of progress or while expanding our efforts, we need to cooperate effectively with others involved.

Such cooperative efforts mean that our ability to work with other people, to fully understand them, to develop satisfactory personal relationships with them, and to secure maximum utilization of thought and effort, will be of prime importance. It is important that, as we learn to work better with our fellowman, we also take the opportunity to devote more attention to improving our human relations. Perhaps it can be said that we have devoted too much attention to the first part of the definition of our profession —to the material things pertaining to the forces and materials of nature, forgetting that they are to be utilized "for the benefit of mankind". This better living for all should not be confined to the material things. We need a fuller, richer life in aesthetic ways as well. We also need to learn to derive the utmost benefit and pleasure from our relationships with others.

Therefore, as we expand our horizons, let us give special attention to our relationship with our fellowman. If we can do just a bit to improve the over-all relationships between peoples, it will help meet the most pressing need of humanity. Agriculture is an industry of peace. Let us help serve her cause.

One way we might help accomplish this would be to do everything possible to extend the knowledge and abilities of our profession to foreign lands. It is obvious that in many countries mankind could be benefitted more by even the rudimentary application of agricultural engineering than can be done here in the further refinements of operations which are already quite efficient. That we have not gone far enough in this direction is evidenced by our difficulty in finding suitable papers from our members for the International Technical Congress of Agricultural Machinery which is scheduled to be held in conjunction with the Paris Machinery Show next March. The general theme of this meeting will be the contribution of agricultural machinery toward raising the standard of living in underdeveloped countries. While several members of our profession have done noble work in this area, there are so few of them that it is difficult to propose a wide range of suitable papers for this meeting. Here again we need to go from individual accomplishments to an organized group effort and to literally extend the horizons of our profession to foreign shores.

Such effort may yield returns we do not foresee, for it is said in the Book of Ecclesiastes 11:1, "Cast thy bread upon the waters: for thou shall find it after many days." Some of the people of other lands appear to have a better appreciation for the arts, for philosophy and for the finer things of life than do we. Perhaps in our associations with them we could learn much "after many days" that would make for our richer experience in the cultural sphere.

Another of the convictions I formed this year, as I learned to know our Society better, was that we, as its older generation, have done too little. From the Engineers Joint Council meeting, I also learned more about the other engineering societies and found that they were much larger than ours, not only in numbers of members but particularly in proportion to the needs or the values of the industries they served in comparison to our agriculture. Many serve industries much smaller and less important than ours, but they have many times more members. To provide the leadership that agriculture so sorely needs, we *must* be strong, both in number and as individuals.

Therefore, I call upon each member of our society to double his efforts. I think we should aim to *triple* the agricultural-engineering student enrollment rate during the next five years. Our new ASAE vocational film might well form the nucleus of these efforts, but, from personal experience, I know that the film alone will not do the job. It was most gratifying to see the complete and effective plan which our Society headquarters staff has worked out to secure maximum effect from this film and the necessary related activities. To be effective, this program needs to be carried out completely and each showing of the film accompanied by an agricultural engineer to attract and hold the young folks' attention, to answer their questions, and to give them leaflets to take home and provide a continual reminder. I urge each member to do his part in this important work. We must promote vocational interest in our profession in every possible way if we are to meet this vital goal. Urging our companies and commercial organizations to provide scholarships for high school seniors in order to get them started in our field is one good way to help. Not only do the scholarships have a direct effect on increasing enrollment, but they serve as a focal point to secure additional interest in agricultural engineering. Small scholarships are sufficient to get a boy started, with plenty of loan funds generally available for good students to complete their training.

That we have not done enough in the past may also be illustrated by examining the titles of the editions of the Yearbook of Agriculture" issued by the U.S. Department of Agriculture. In 1940, the title was "Farmers in a Changing World". The book covering the 1943-47 war years was named "Science in Farming". Following were books with titles such as "Grass," "Trees," "Crops," "Insects," "Marketing," "Water," and many others. Not yet do we have a Yearbook devoted to agricultural engineering.

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1960 ASAE Award Winners

CYRUS HALL McCORMICK MEDALS

Were Awarded to Fred A. Brooks and Walter H. Silver

Fred A. Brooks

RECOGNITION for exceptional achievements in both science and engineering in their application to agriculture is implied in the selection of a distinguished member of the agricultural engineering profession to receive a Cyrus Hall McCormick Medal award in 1960. This award honors one who richly merits the professional recognition thus accorded him, not only for his concrete achievements but also for the high professional ethics and warm friendliness so characteristic of the man.

It was at Minneapolis, Minnesota, on May 1, 1895, that Frederick Augustus Brooks was born to Morgan and Frona Marie Brooks. When it came time for him to enter college, he matriculated at the University of Illinois, where his father was then professor of electrical engineering. Fred graduated in 1917 with honors in electrical engineering. From 1918 to 1920 he was enrolled as a graduate student at the Massachusetts Institute of Technology where he was awarded a master of science degree in 1919 and a doctor of science degree in aeronautical engineering in 1920. Then, in 1927, in recognition of his stress analysis studies in industrial applications, he was awarded the professional degree of mechanical engineer by the University of Illinois.

Prior to entering on his career as research agricultural engineer, in which he has achieved international distinction, Fred Brooks' professional record shows that he served several industry organizations in an engineering capacity over a period of about ten years. These included airplane designer for Curtiss Aeroplane & Motor Corp., and assistant engineer of Dunlop Tire & Rubber Corp., both of Buffalo, N. Y.; also chief engineer of Johnson Gear Co. and of Apache Motor Corp., and assistant to the chief engineer of Byron Jackson Co., all three located in California.

For one year (1922-23) he served as teaching fellow in the physics laboratory of the University of California at Berkeley. He returned to the University in 1931 when he accepted appointment as associate agricultural engineer in the experiment station on the Davis campus, and 1934 he was also made associate professor of agricultural engineering. Since 1941, he has been classified as professor of agricultural engineering and agricultural engineer in the experiment station.

The fields of agricultural engineering in general, and of plant environment in particular, have been greatly enriched by the scientific contributions of Dr. Brooks over the past thirty years. His early studies dealt with the problem of abrasive effects of agricultural dusts on internal-combustion

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Walter H. Silver

EVEN though this recipient of a Cyrus Hall McCormick Medal for 1960 claims to have little in common with others who have heretofore received this award, he ably merits recognition for "exceptional and meritorious engineering achievement in agriculture." He holds more than a hundred agricultural equipment patents, with some still pending, and his former associates say that his exemplary career as engineer and designer of agricultural implements and machines should provide great inspiration to newcomers to the agricultural engineering profession which he helped to found.

Walter Herbert Silver was born at Wahoo, Nebraska, October 17, 1890, the son of William and Jessie Groff Silver. As a young lad, he received but little formal schooling, but those who know him say that not to this day has he ceased being a student. Barely had he reached the eighth grade, when his father, then a practicing attorney in Springfield, Ohio, became seriously ill, so that Walter and a brother had to go to work to help care for the family, which also included three other brothers and a sister. Through the father's efforts among friends, the boys for the next few years were never without counsel, guidance and instruction by competent and friendly instructors. Walter attended night classes at an art institute, briefly studied engineering under Wittenberg College instructors and English and drafting at the YMCA with his father as instructor.

For a time this young man worked as a pin boy for a piano plate company, but at the age of eighteen, through the efforts of his father, he went to work as a draftsman for the chief design engineer at the Champion Works of International Harvester Company in Springfield. There he became thoroughly grounded in the fundamentals of product design details, malleable and gray iron foundry practice, molding-machine design, and production-tool design and was assigned design work on tedders and hay rakes. Later he was employed for about two years by the Springfield Machine Tool Company where he worked as draftsman and detail designer.

In 1912 he accepted a job offered him in the engineering department of John Deere Harvester Works at East Moline, Illinois. However, on arrival there ready to go to work, the individual who had hired him was out of town; and since no one else around the place knew anything about the deal, Walter decided to hop a streetcar for Moline where he signed on as a junior design engineer at the John Deere Plow Works. There during the next forty-seven years his assignments included almost all phases of agricultural equipment design, research and development.

That same year (1912) will be remembered by old-timers as a time when many farm implement manufacturers were questioning whether to build gasoline traction engines or attempt to ignore them. It was not until 1917, however, after a Deere one-row motor cultivator failed to produce the desired market appeal, that Walt Silver was asked to develop a two-row model.

Not in months, but in just two weeks, using makeshift materials, hastily designed parts, and an Avery friction-drive engine, Mr. Silver succeeded in putting into the field a practical, working two-row motor cultivator. Later that year he improved the machine, made five outfits provided with foot control of the powered drivewheels — and proved on Iowa farms the following summer that he had developed what

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The American Society of Agricultural Engineers awards annually The Cyrus Hall McCormick Medal for "Exceptional and Meritorious Engineering Achievement in Agriculture," the John Deere Medal for "Distinguished Achievement in the Application of Science and Art to the Soil," and the Metal Building Manufacturers Association Award for "Distinguished Work in Advancing the Knowledge and Science of Farm Buildings." Presentations of the 1960 Awards were made during the Society's 53rd Annual Meeting at Ohio State University, Columbus, June 15.

THE JOHN DEERE MEDAL
Was Awarded to William V. Hukill

William V. Hukill

SELECTION of the individual to become the 1960 recipient of the John Deere Gold Medal, awarded annually by the American Society of Agricultural Engineers, was not a difficult one in the light of his professional record. The Society's awards jury found abundant evidence of conspicuous accomplishment in agricultural engineering over a 35-year period, and wholly in the field of research.

William Virgil Hukill was born October 5, 1901, at Corvallis, Oregon, the home of Oregon State College, from which he graduated with a bachelor of science degree in mechanical engineering in June of 1923. His first job on graduation was with a surveying party in Oregon, but beginning in January 1924 he has since been in the continuous employment of the Agricultural Engineering Research Division (Agricultural Research Service) and predecessor organizations of the U.S. Department of Agriculture.

His first assignment with the USDA was a research study (1924-36) on the transportation of perishable fruits and vegetables from producing to marketing centers. For this purpose he developed instruments and techniques for measuring and controlling temperature, relative humidity and air circulation in refrigerated railway cars and highway trucks. Also, he measured the heat production of representative fruits and vegetables under storage conditions, using apparatus that he himself designed and built specially for the purpose.

From 1936 to 1941, while serving as assistant chief of the division of farm structures in what was then known as the Bureau of Agricultural Engineering, Mr. Hukill helped to organize and supervise research on the storage of grain, potatoes, sweet potatoes and apples, and on the housing of livestock. During 1941 he was assigned to conduct engineering studies of the cooling and storing of apples and pears as part of a broad USDA study of the deciduous fruit

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METAL BUILDING MANUFACTURERS ASSOCIATION AWARD
Was Received by Gordon L. Nelson

Gordon Leon Nelson

FOR notable work in adapting science and engineering to the development and improvement of farm service buildings, Gordon Leon Nelson, professor of agricultural engineering, Oklahoma State University, Stillwater, was chosen as the 1960 recipient of the MBMA-ASAE Distinguished Service Award. The particular purpose of this award is to give recognition to individuals of the younger generation of agricultural engineers for significant effort to advance the design, construction and utility of agricultural structures.

The award was instituted by the American Society of Agricultural Engineers in 1959 at the request of and in collaboration with the Metal Building Manufacturers Association. It is administered by the Society, and selection of recipients of the award is made by a special awards committee. Rules for the award provide that it shall be conferred only on ASAE members in good standing and under 45 years of age.

The award provides for two-fold recognition. The individual selected to receive it is given an engraved wrist watch and a certificate of award, and the university from which the recipient received his bachelor of science degree is given an engraved plaque in recognition of its contribution to preparing the recipient for distinguished service in his chosen field.

Gorden Nelson, the second recipient of this award, was born and reared on a farm near Granite Falls in west central Minnesota. One of his professional associates avers that, while Gordon liked the farm, he disliked the hard work and long hours characteristic of farm life at the time he was a youngster which may account for his early interest in agricultural engineering. Indeed many a farm-reared boy in this century has experienced the engineering urge. The result has been that service in adapting engineering to farming and farm living has been of inestimable value to agriculture and farm people.

And so it was in 1938 that Gordon Nelson entered the University of Minnesota and enrolled as a student in the professional agricultural engineering curriculum. It is said that he early manifested a particular preference for courses dealing with farm structures. He graduated from the University in June 1942 with the degree of bachelor of agricultural engineering.

His chosen professional career, however, was temporarily interrupted when, soon after graduation, he entered upon active duty with the U.S. Navy, with which he served for the duration of World War II, in the Aleutian Islands and in various locations in continental United States. In recognition of his service in the Navy he was awarded a certificate in naval engineering design in December 1945 by the postgraduate school of the U.S. Naval Academy.

Following service with the Navy, he was employed for two years by the Portland Cement Association as agricultural engineer, but in 1948 he accepted appointment as associate professor of agricultural engineering at Oklahoma State University, where he has since been employed, except for one year (1954-55) spent in pursuing graduate work in agricultural engineering at Iowa State University.

In January 1951, Gordon was awarded the master of science degree in agricultural engineering by Oklahoma State University, and in December 1957, Iowa State University conferred on him the degree of doctor of philosophy in agricultural engineering and theoretical and applied mechanics.

Dr. Nelson has conducted extensive research in several areas of agricultural engineering notably the following: hot weather

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. . . Award Winners

Fred A. Brooks

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engines and contributed greatly to developing testing techniques and standards for air cleaners. His principal work, however, for the past twenty years has centered on the engineering aspects of the climate in which agricultural plants grow. His introduction to this latter field was through research on the problem of protecting citrus orchards from frost. All modes of heat transfer were involved and each was considered in detail. The importance of radiant heat transfer in the orchard became quickly apparent and Dr. Brooks devoted considerable time to it. His work on atmospheric radiation and its effects on plant environment has received international recognition. All his investigations in this field have resulted in his becoming a recognized authority on microclimatology.

As a result of his research achievements in agricultural engineering, various agencies have called on Dr. Brooks to contribute to the general welfare in times of both war and peace. In 1939, Dr. Brooks spent four months as research visitor in chemical engineering at the Massachusetts Institute of Technology and as research fellow in mechanical engineering at Harvard University. For a similar period in 1943, he was a consultant in surface climatology to the Chemical Warfare Service at the Dugway proving grounds in Utah. Beginning in late 1944, he saw four months of sea duty as a technician with the U.S. Navy, where he served as consultant on the effect of surface-air turbulence on smoke screens. For six months in 1947 he was a research fellow at Harvard University's Blue Hill Meteorological Observatory. In 1953 he was a participant in the U.S. Air Force turbulence research project in Nebraska. For six months in 1955, with a fellowship and travel grant from Harvard University, he visited nine universities, the U.S. Department of Agriculture, U.S. Weather Bureau, and three military stations to study microclimate research. Under the auspices of Standard Research Institute, he contributed to the solar energy symposium in Arizona. In 1957 he was one of four delegates from the United States to the UNESCO symposium on arid zone climatology at Canberra and Melbourne, Australia. In 1959 he was awarded a Guggenheim fellowship for research in England.

One of his superiors at the University of California pays Dr. Brooks a warm tribute as scientist, engineer and teacher in these words:

"I believe his greatest contribution lies in appreciation of the part which variations in thermal conditions of the atmosphere and the soil have on plant welfare. In establishing this thesis, he has of necessity become thoroughly familiar with many other properties and characteristics of the atmosphere and the soil. This interest, and the assiduity with which Dr. Brooks approached the problem, has resulted in a position of world leadership in the field of microclimatology.

"A characteristic which Brooks exhibits continuously is intellectual tenacity. He does not give up a problem until certain answers emerge. Also, he possesses unbounded enthusiasm for new ideas, and this enthusiasm has not wavered during the years. He attacks a problem today with the same zest he demonstrated thirty years ago.

"Quite apart from his substantial contributions in micrometeorology. Dr. Brooks has worked ceaselessly and patiently to improve the professional quality of work in all branches of agricultural engineering. When in charge of graduate study on the Davis campus, he was known by students and faculty alike as a hard taskmaster, insisting always on attainment of the highest possible goals in graduate instruction and achievement. His colleagues and co-workers have felt his constant prodding to upgrade the level of their activities. Through his salubrious influence on other people he has contributed greatly to the development of a real *esprit de corps* in agricultural engineering.

Dr. Brooks is the author and coauthor of a total of seventy-five technical and scientific articles, papers, and bulletins, some of which have been presented at meetings of the American Society of Agricultural Engineers and printed in its publications.

In 1934 Fred Brooks was enrolled as a member of the American Society of Agricultural Engineers in the grade of Member, and in 1947 he was elected to the grade of Fellow. He is also a member of the American Society of Mechanical Engineers, American Meteorological Society, American Geophysical Union, and Society Sigma Xi.

In September of 1929, Fred Brooks married Margaret Henshaw Ward, and they have four daughters — Audrey, Emily, Deborah and Brenda. Each of the daughters is married, and there is a total of five grandchildren.

Fred says his civic duties have been indirect, first in Berkeley as a member of the industrial association and later at Davis as the husband of a nine-year member of the school board. The main non-university activity of the Brooks family at Davis was originally the development of a small farm, on which the four daughters grew up with direct responsibilities for chickens, cow and calf, goats, horses, dogs and tractors. However, the farm proved to be too near the University experiment station when it expanded in 1953. Fred says his present hobbies are his five grandchildren, photography and architecture.

From the warmth with which he was commended as a candidate for the McCormick Medal, there is abundant evidence of the admiration and esteem approaching affection wherein Fred Brooks is held by his colleagues in the agricultural engineering profession.

Walter H. Silver

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amounted to a general-purpose tractor that could be used for mowing, cultivating, disking, planting, and pulling binders and drag harrows. That fall (1918) Walt Silver was made foreman of the John Deere Plow Works experimental department. For three years, 1917 to 1920, he devoted special attention to work on motor cultivators along with his work on horse and tractor-drawn moldboard and disk plows and horse-drawn cultivators and lister planters.

While Deere was developing and expanding its tractor business, Walt Silver was devoting his attention to the many-faceted task of designing more versatile, more efficient, more economical tillage tools for tractor use. Many a time, his former associates say, he was to influence the evolution of John Deere tractors simply by developing implement improvements that made the company's capable tractor engineers hustle to overtake.

He is credited with developing many "firsts" in his company's line of farm implements. These included power-lift disk tillers, disk tillers with mechanical depth control and adjustable cutting angle, integral tool bars, integral bedders, weight transfer of integral equipment (to improve tractor traction) by use of lift springs, a three-point tractor hitch with governed mechanical weight transfer, non-preloaded plow standard safety trips, and telescoping three-point tractor-hitch draft links which simplify implement hookup.

Certain improvements in the design of listers and bedders, which Mr. Silver directed, are credited by Deere officials as giving the company its strong position in this class of equipment. Also the company's truss-frame plow design and high-speed, light-draft bottoms are among the many improvements developed under his direction.

Nor has the least of his service to John Deere and to agriculture, say his former company associates, been the kindly guidance he has given young men in his and other research departments of the company.

Prior to his retirement two years ago, Mr. Silver was for many years chief engineer of the John Deere Plow Works, and in recent years he also served as tillage tool consultant to the parent company's product research department. If this McCormick medalist is less well known than many of those comprising the pioneer group of agricultural engineers, say former associates, perhaps he is better known among farmers, thousands of whom have consulted him over the years.

Mr. Silver has been a member of the American Society of Agricultural Engineers since 1920. He belongs to the Doric Lodge of Masons in Moline, and is a member of the Moline Consistory and Co-ordinate bodies and of the Medinah Temple AAONMS in Chicago. He is also a member of the Elks lodge in Moline; and since moving to his present residence in Brownsville, Texas, he has become a member of the United States Propeller Club.

Mr. and Mrs. Silver are the parents of three children, and the grandparents of five. Their son, J. Sterling Silver, with John Deere Plow Company, San Francisco, has one daughter, Connie Jo. The older daughter, Mrs. L. A. Nelson, resides at Stanley, North Dakota, and her three children are Sally, Dean, and Wayne. The younger daughter, Mrs. Peggy England, residing at

Brownsville, has one daughter, Claudia Jeanne.

Walt doesn't claim to possess any particularly absorbing hobbies. He has a liking for hi-fi music and any kind of sports, and says he is fairly good at table tennis, that is, for a 69-year-old. He likes air travel and has flown 800,000 air miles. He enjoys fishing for "niggerfish," and he has done some drawing and painting.

One of his friends believes that Walter Silver "is perhaps the happiest when he can get a group of his friends together at his home and prepare a barbecue dinner for them." Another friend says this about his cooking: "He can take a steak as tough as the moldboard on a John Deere plow, and when served it just melts in your mouth."

Walter Silver's distinction as a farm implement design engineer does not lie merely in the list of the hundred and more agricultural equipment patents that have been issued to him during the years of his active service with the Deere organization. Rather it is in the caliber of his creative talent in sensing agricultural conditions and requirements and in developing designs of implements and machines that measured up to those needs to a highly successful degree. Indeed, it may be said that here is one of those rare individuals, who achieved conspicuous success as an engineer not because of formal academic training as an engineer, but rather in spite of a lack of it.

William V. Hukill

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industry of the Pacific Northwest. His work on this project was enthusiastically acclaimed by both growers and shippers of these fruits.

Since 1943, Mr. Hukill has been located at Ames, Iowa, where he has been in charge of USDA research on the storing and drying of grain, in which he has made important engineering contributions. For example, this work has demonstrated (1) that temperature differences due to weather changes set up convection currents in a grain mass that carry moisture from warm to cold parts of a storage, (2) that rapid deterioration occurs in the resulting damp portions of the grain, and (3) that undesirable effects can be controlled by simple systems of aerating and cooling the grain. Systems developed by Mr. Hukill based on these research results have made it possible to store grain safely for long periods and at much less cost. These findings have been widely applied in the USDA grain storage programs at bin sites of the Commodity Stabilization Service, also in bulk storage of grain in ships of the U.S. Reserve Fleet.

Mr. Hukill has rendered invaluable service in developing new fundamental knowledge for storing and drying grain, and he now has in preparation for publication a comprehensive report on the basic principles of drying grain, including equations expressing the relationship of specific factors to the drying rate. During the past thirty years, he has contributed a total of sixty-odd technical and semi-technical papers reporting the results of his research studies, a goodly portion of which have been presented at ASAE meetings and subsequently published in Society publications. His publications, in addition to technical papers, include bulletins and contributions to books on instrumentation, product storage and transportation, and grain drying. He has been responsible for a number of public service patents.

He has stimulated and guided interest in the entire subject of grain storage and conditioning and is directly or indirectly responsible for much of the research now under way. His agricultural engineering colleagues regard him as the final authority on the basic principles of storing and drying grain, and one who probably has produced more fundamental data on this subject than anyone else in the country.

Important contributions to developing instrumentation and procedures have been made by Mr. Hukill for many phases of agricultural engineering research. Also, because of his thorough training and broad experience, he has been particularly helpful in training younger engineers in planning research, in the use of instruments, and in methods of analyzing research data.

Mr. Hukill was admitted to membership in the American Society of Agricultural Engineers in 1937 in the grade of Member, and in recognition of his conspicuous research work he was elected a Fellow of the Society in 1955. He is a past chairman of the ASAE Farm Structures Division and has participated in many of the Society's committee activities. He is also a member of the American Society of Heating, Refrigerating and Air-Conditioning Engineers and of Sigma Xi and Gamma Sigma Delta.

Bill Hukill's wife is the former Maybelle Coffman. Their children are Winnie, Virginia, and Bill, Jr., all married and living in or near Iowa — and between them, they are the parents of Bill's nine grandchildren who he says, constitute his "main pride and hobby." In fact, one of his friends at Ames says the only time he has ever seen Bill really relax is when he is playing with his grandchildren in the park.

Over the years Bill Hukill has acquired a wide circle of personal friends. These include not only professional associates but also other kindred spirits in the communities in which he has resided. Among these friends he has earned an enviable reputation for his skill at contract bridge. He admits to really enjoying bridge, also chess when he can find a challenging opponent. In years gone by he has also played a great deal of tennis but says his most strenuous sport now is bowling, which he is said to play with the skill of a professional.

One of his colleagues says that Bill Hukill probably holds the record for more miles of freight train travel than any other agricultural engineer in the country.

One of Mr. Hukill's former coresearchers provides a vivid description of their experiences in the 1930's related to preventing the freezing and overheating of apples in refrigerated railway cars hauled by fast freight between the Pacific Northwest and New York, which required their riding the freight trains during the coldest part of the winter. For this purpose Bill wired up thermocouple leads from a series of points within the cars to the car roofs, to be read whenever the trains stopped day or night. For quick connections between the leads and the potentiometer, Bill rigged up snap connectors made from clothespins. A coworker says he can still picture Bill during the night hours in his flopping galoshes, with scanty winter clothing as a shield from twenty-below-zero Dakota winds, going from the top of one freight car to the next with a flashlight sticking out of his pocket, while he lugged a heavy potentiometer in one hand and carried a thermos bottle of ice water in the other for his "cold contract." Then, with tears in his eyes from the subzero breeze, he would sit down on the running board, ready his thermos-bottle cold contact, wiggle each clothespin till he was sure of a good connection, and then with the flashlight make readings of temperatures within the car.

Another of his fellow researchers relates that Mr. Hukill, during the early days of refrigerator cars and refrigerated transportation of perishable fruits and vegetables from both the west coast states and Florida, made many contributions to developing instrumentation for obtaining data under unfavorable conditions. His hot wire anemometer was developed originally to measure airflow at low rates and in inaccessible places in refrigerator cars. He learned a great deal about the use of thermocouples, heat flow meters, and similar equipment which he has not only used himself but has also taught many younger engineers to use. This same fellow researcher sums up this 1960 John Deere medalist as a research engineer with a fine personality, sound judgment, a logical mind, and a strong determination to dig out the basic facts concerning any problem for which he seeks a solution.

Gordon L. Nelson

(Continued from page 459)

sheltering of lactating dairy cattle; mechanics of pole stability; development of improved structural components for farmbuilding construction, including lightweight trussed rafters, stressed-skin panels and one-hinged, glue-laminated arches; grain drying and conditioning; performance of farm egg coolers; wind loads on open shelters; mechanics of mist formation, transportation and evaporation for cooling animal shelters; use of fog and mist for cooling poultry, and design and construction of wind tunnel for agricultural engineering research. His teaching activity has included graduate courses on structural analysis and design of light structural frames, farm residences, and agricultural processing engineering.

In professional society affiliations, Gordon has limited his memberships to the American Society of Agricultural Engineers, the American Society for Engineering Education and the Naval Reserve Association. It is also understood that just recently he joined the local DFC (Defeated Candidates Club) after an unsuccessful race in the local school board election. He is also a member of Tau Beta Pi, Sigma Tau, Phi Kappa Phi,

(Continued on page 475)

53rd Annual Meeting

Held at Ohio State University
June 12 to 16, 1960

N. G. Fawcett, president of Ohio State University, extended a message of welcome to Ohio during the Wednesday evening banquet

Lloyd W. Hurlbut *(right)*, chairman, agricultural engineering department, University of Nebraska, accepts the gavel from retiring President L. H. Skromme, chief engineer, New Holland Machine Co., during the inauguration ceremonies for the new president, held Wednesday evening

AN attendance of over 1200, including women and children, was recorded at the 53rd Annual Meeting of ASAE held on the campus of Ohio State University. An outstanding performance in handling the activities was in evidence at all times and much credit is due R. D. Barden, chairman, agricultural engineering department; B. J. Lamp, Jr., chairman of the meetings committee; and the Ohio Section members for a job well done. Registration began Sunday afternoon and a good turnout was on hand for the Sunday evening buffet dinner.

AWARD WINNERS

1960 ASAE award winners include Fred A. Brooks *(upper left)* and Walter H. Silver *(upper right)* recipients of the Cyrus Hall McCormick Medal; William V. Hukill *(lower left)* recipient of the John Deere Medal; and Gordon L. Nelson *(lower right)* recipient of the Metal Building Manufacturers Association Award. Retiring President L. H. Skromme made formal presentations of the awards during the Wednesday evening banquet. Further details will be found on pages 458 and 459

Meeting Sessions

The technical sessions opened on Monday morning with five concurrent meetings in the following divisions: Power and Machinery – Programs A and B; Electric Power and Processing; Farm Structures; and Soil and Water. Monday afternoon sessions consisted of the following divisional programs: Soil and Water; Power and Machinery – Programs A and B; Electric Power and Processing; and Farm Structures.

Concurrent sessions continued on Wednesday morning, numbering seven: Farm Structures; joint Farm Structures and Electric Power and Processing; Soil and Water; Power and Machinery – Programs A and B; Electric Power and Processing; and a special session of the American Grassland Council. Five concurrent sessions were held Wednesday afternoon in the following divisions: Electric Power and Processing; joint Farm Structures and Electric Power and Processing; Soil and Water; and Power and Machinery–Programs A and B.

The Soil and Water Division held two joint sessions with the Public Land and Public Works group on Thursday morning.

W. H. Friday *(left)*, representative of the Purdue bowling team, accepts the winning trophy from N. G. Fawcett, president of Ohio State University, for the team's first place standing in the ASAE bowling contest

TOURS

Several tours were conducted Tuesday afternoon to places of historical interest and to local industries. Shown below is the group that toured the Timken Roller Bearing Co. plant in Columbus

Representatives from the host groups sponsoring the coming 1960 Winter Meeting and the 1961 Annual Meeting were on hand to extend invitations to attend their respective meetings. *(Above)* Mrs. J. K. Jones, whose husband is chairman of the local arrangements committee for the Winter Meeting, presents an invitation to Memphis in the form of a cotton boll corsage to Mrs. E. J. Matthews, whose husband is associate professor in agricultural engineering at University of Arkansas. *(Below)* Leon F. Charity, chairman of Iowa Section, presents L. H. Skromme with a colorful vest promoting "Aim for Ames in '61"

Officers for the National Council of Student Branches *(below)* elected on the final morning of the meeting are as follows: *(left to right)* Richard R. Sheppard, Michigan State University, 2nd vice-president; Robert Hansen, Ohio State University, president; J. Robert Cooke, North Carolina State College, 1st vice-president; and Maylon London, University of Georgia, secretary

General Session

B. J. Lamp, Jr., chairman of the meetings committee, presided at the General Session, Tuesday morning. Presentation of the winning student paper. "Nomograph for Determining Minimum Grades for Tile Drains Carrying Coarse Sediment," was made by George E. Merva, Ohio State University. Murray D. Lincoln, president, Nationwide Insurance Companies. Columbus, Ohio, spoke on the new look in agriculture. The president's address by L. H. Skromme followed and was entitled "Extending Our Horizons." See page 427 of this issue for complete address. The annual business meeting completed the general session.

Special Activities

The special activities during the 53rd Annual Meeting began on Sunday evening with a buffet dinner and entertainment, with Monday evening devoted to a beef barbecue dinner, followed by square dancing. Special ladies' and children's programs were enjoyed, as well as organized tours on Tuesday afternoon, which included the Battelle Memorial Research Institute, Industrial Nucleonics, Timken Roller Bearing Co., Upper Hocking Watershed, and Ohio State University Campus. An American Grassland tour, including visits to dairy and beef farms, Sohio Chemical Co. Nitrogen Plant, Lima, Ohio, and a complimentary chicken barbecue dinner, was also enjoyed on Tuesday afternoon. The FEI dinner for students, an annual affair during the ASAE Annual Meeting, was held on Tuesday evening. Open House at the new Ohio Agricultural Experiment Station, Wooster, was an item of special interest on Thursday. The bowling tournament on Wednesday evening and swimming were added entertainment attractions.

Annual Dinner Program

John T. Mount, administrative assistant to the president, Ohio State University, was master of ceremonies at the Annual Dinner,

(Continued on page 464)

Enjoying a break in the festivities are long-time ASAE members G. W. McCuen, professor emeritus and former head of agricultural engineering department, Ohio State University, and W. J. Parvis, rural sales manager, Public Service Company of Indiana, Inc. Their combined ASAE memberships span 76 years

Technical paper requests received special attention during the meeting with Judy Reinhard and Sandy Gill (daughter of ASAE member W. E. Gill) in charge. Receiving papers are R. E. Wagner *(left)*, American Potash Institute, and W. A. Junnila, University of Minnesota

(Above) George D. Scarseth *(left)*, director of research, American Farm Research Association, was featured speaker at the FEI Student Dinner held Tuesday evening, sponsored by the Farm Equipment Institute. Karl D. Butler, farm counselor, Avco Corp., was in charge of the program and introduced Dr. Scarseth

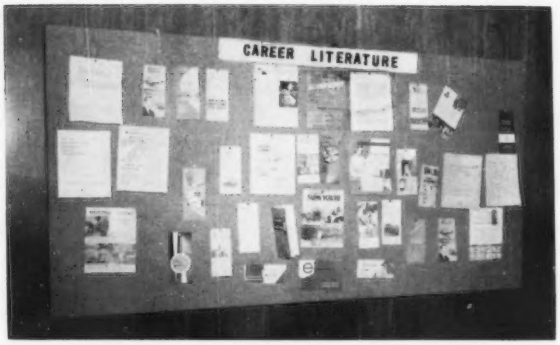
(Below) W. L. Sprick *(left)*, engineer, Industrial Engine Division, Caterpillar Tractor Co., presented the FEI Trophy Awards during the FEI Student Dinner. *(Left to right)* Sprick; Jerry D. Fritschle, University of Illinois (class A winner); and J. Robert Cooke, North Carolina State College (class B winner)

. . . Annual Meeting

(Continued from page 463)

Winner of a blue ribbon award in the radio and television extension exhibits is the entry by Donald P. Brown, Michigan State University, entitled "Progress Through Agricultural Engineering" and "Electricity at Work"

A twin-engine radio-controlled tractor, developed by the Oliver Corp. was on display. See page 470 for further details



(Right) Twenty-three agricultural engineering departments and several organizations provided copies of career literature for display during the meeting. This technique of "trading ideas" created much interest and should result in overall improvement of materials developed in the future

which was held on Wednesday evening, with the invocation being pronounced by Virgil Overholt, professor emeritus, Ohio State University. L. H. Skromme, president of ASAE, presented the following awards: Fred A. Brooks, professor of agricultural engineering and agricultural engineer, Agricultural Experiment Station, University of California, Davis, and Walter H. Silver, retired chief engineer, John Deere Plow Works, Moline, Ill., received the Cyrus Hall McCormick Medal; William V. Hukill, principal agricultural engineer, Agricultural Research Service, USDA, Iowa State University, Ames, received the John Deere Medal; and Gordon L. Nelson, professor of agricultural engineering, Oklahoma State University, Stillwater, received the Metal Building Manufacturers Association Award. Following the presentation of Awards, L. W. Hurlbut, professor and chairman, agricultural engineering department, University of Nebraska, was inaugurated as the new ASAE president. The new career motion picture entitled "Agricultural Engineering — The Profession with a Future," produced by ASAE in cooperation with the USDA, was premiered during the annual banquet program. The entertainment throughout the dinner hour was provided by Gary Lyons, furnishing dinner music. The Novelaires, an unusual and talented youth combo group, presented a most interesting program.

Student Activities

The following officers were elected to serve on the National Council of ASAE Student Branches for 1960-61: President, Robert Hansen, Ohio State University; first vice-president, J. Robert Cooke, North Carolina State College; second vice-president, Richard R. Sheppard, Michigan State University; and secretary, Maylon London, University of Georgia. President L. H. Skromme was the featured speaker at the Monday morning student program. His address was followed by the presentation of winning papers in the ASAE Student Paper Award competition. First place award went to George E. Merva, Ohio State University for his paper entitled "Nomograph for Determining Minimum Grades for Tile Drains Carrying Coarse Sediment," which was presented during the ASAE annual business meeting. Second place winner was Joseph C. Hurlburt, Pennsylvania State University, for his paper entitled "Telescopic Wagon Tongues." Tom Krumboltz, Iowa State University, was third place winner for his paper entitled "Horizontal Silo Unloading Attachment for a Farm Tractor Loader."

Karl D. Butler, farm counselor, Avco Corp., introduced the featured speaker, George D. Scarseth, director of research, American Farm Research Association, at the FEI Student Dinner on Tuesday evening. W. L. Sprick, engineer, Caterpillar Tractor Co., presented the FEI trophy awards to the following ASAE Student Branches in recognition of outstanding initiative and accomplishment: Group A — Winner, Illinois Student Branch; Honorable mention, Georgia and Iowa Student Branches; Group B—Winner, North Carolina Student Branch; Honorable mention, Oklahoma and Maine Student Branches. For the purpose of the competition, student branches were divided into two groups based on size of membership—Group A comprising the larger branches and Group B the smaller. In each group a trophy and certificate are awarded the winning branch along with honorable mention certificates to the second and third place winners.

THE FIVE STEP PLAN

A Five Step Plan for explaining agricultural engineering to the public, and particularly to high school students, was presented at the Cabinet meeting on Sunday evening. The plan, developed around the ASAE career motion picture, was offered as a guide to help ASAE sections and other groups to promote the film. The five steps are:

Step 1 involves a promotional flyer publicizing availability and content of film to be used by sections, departments, companies and individual members to stimulate interest in showing the film. Copies should go to 4-H, FFA, JETS, scouts, science clubs, science and math teachers, TV stations, magazines and all other similar groups.

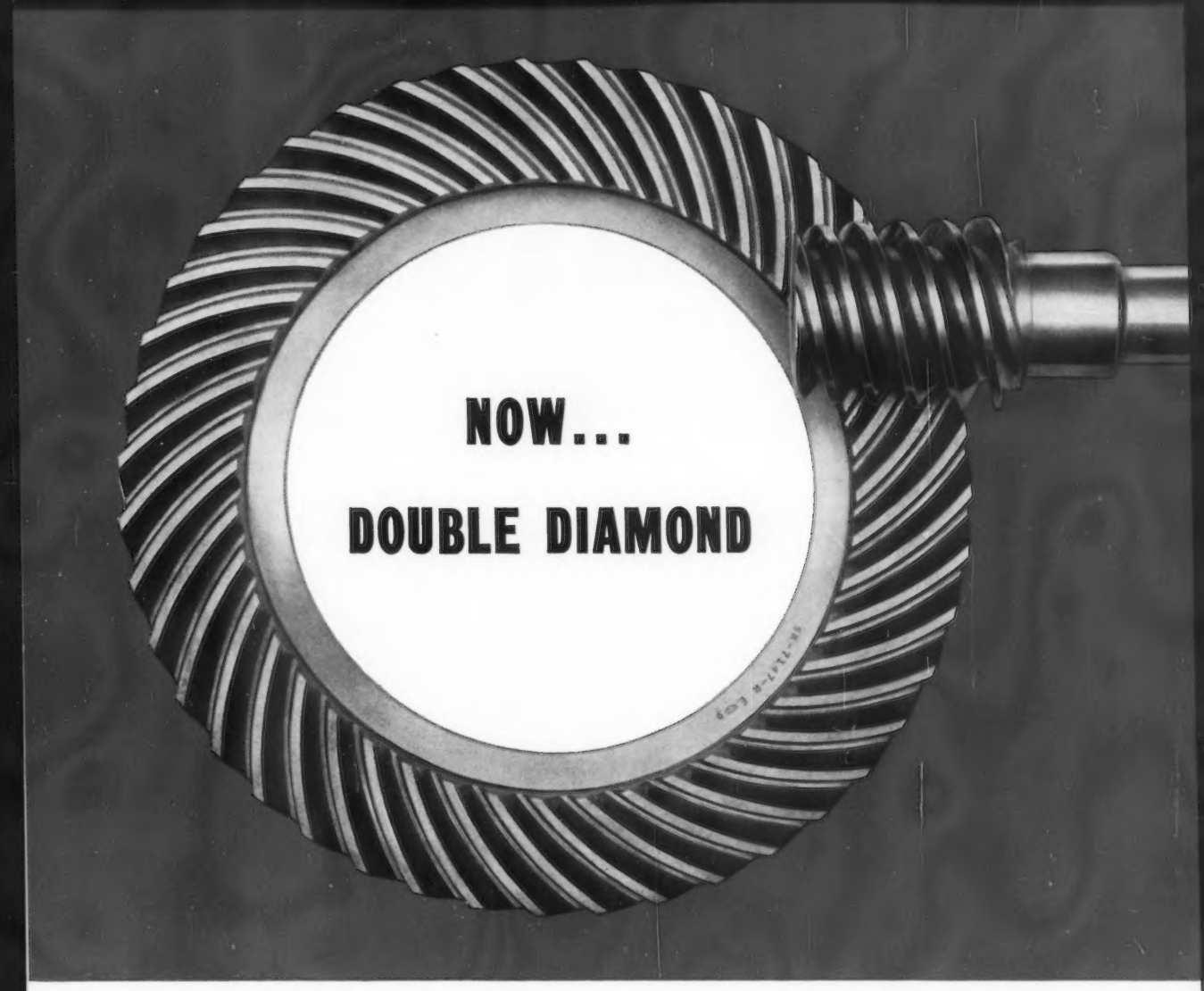
Step 2 involves acknowledging requests and scheduling film to be handled by section committees or departments.

Step 3 involves advance mailing of supplemental promotional materials to organizations who plan to view the film.

Step 4 provides for leaflets to be supplied to those who see the film.

Step 5 is the follow-up furnishing full description of agricultural engineering, curriculum data and enrollment qualifications.

ASAE members interested in further details in the five-step plan are urged to contact their local section officers or the nearest agricultural engineering department head.



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Wayne H. Worthington

R. C. Conner

W. L. Voegeli

J. H. Anderson

Wayne H. Worthington, past-president of ASAE, and manager, Heinrich Lanz Co., Manheim, Germany, the German subsidiary of John Deere and Co., was one of three distinguished Oklahoma State University alumni who were recently inducted into the OSU Alumni Hall of Fame. The honor was awarded at the annual Oklahoma State reunion banquet in conjunction with the University's graduation activities. Wayne is a 1910 mechanical engineering graduate of OSU and finished at the top of his class at the age of 18. He, along with other classmates, also was inducted into the Half Century Club, composed of all alumni who graduated 50 or more years ago.

Ray C. Conner, general manager of the Mobile Hydraulics Div., Vickers Inc., Detroit, Mich., was elected a company vice-president recently. He joined the company in 1948 and after serving in various engineering and sales capacities he was appointed general manager of the Mobile Hydraulics Div. in 1957, when this division was formed.

Wendelin L. Voegelie, general sales manager of the Farm Equipment Div., Allis-Chalmers Mfg. Co., was appointed recently to the National Defense Executive Reserve of the Business and Defense Services Administration, U.S. Department of Commerce. The Reserve, composed of businessmen and some city government technicians, is being created to staff the operations of a national protection agency in case of emergency.

W. M. Bruce

R. E. Storie

James H. Anderson has recently been named head of the agricultural engineering department at the University of Tennessee, Knoxville succeeding C. W. Bockhop, who has joined the staff at Iowa State University. Dr. Anderson previously was on the agricultural engineering department staff at Clemson College, Clemson, S. C. He is a native of Georgia, his birthplace being Odum. His B.S. degree in agricultural engineering was earned in 1949 from the University of Georgia and in 1954 he received an M.S. degree from North Carolina State College, where he also was a research instructor. His Ph.D. degree was received from Iowa State University in 1957, just before joining the Clemson College staff. He has been an ASAE member since 1950 and is also a member of Alpha Zeta, Gamma Sigma Delta, Sigma Xi, and Phi Kappa Phi fraternities.

William M. Bruce has been designated as acting chief of the Harvesting and Farm Processing Research Branch of the USDA Agricultural Engineering Research Division at Beltsville, Md. He replaces H. F. Miller, Jr., who has taken a position with Deere & Co.

R. Earl Storie, professor of Soils and Plant Nutrition, and soil technologist at the California Agricultural Experiment Station, University of California, Berkeley, retired on July 1 after 39½ years of service with the University. He has been in charge of Soil Survey for the past 20 years, and is chairman of the California Soil Correlation Committee, and consultant in the California Soil Vegetation Survey. He was born in Waitsburg, Wash., in 1894, and received a B.S. degree from the University of California in 1917.

He is best known as the originator of the Storie-Index for rating soils and other land classification endeavors, which are extensively used throughout the world. His international contacts are many – helped start Mexico in its irrigation land classification program in 1926; cooperated with the Chilean Institute of Land Colonization in 1933-1934; collaborator of U.S. Office of Foreign Agricultural Relations in 1944 in Colombia; soil consultant FAO United Nations; member of United Nations Technical Assistance Mission to Bolivia in 1950; chairman of Standing Committee on Soil

NECROLOGY

C. A. Ocock

Charles A. Ocock, Charter-Life Fellow of ASAE, died on May 14 in Racine, Wis., at the age of 86. A native of Illinois, he was born February 17, 1874, on a farm near Marengo. He graduated from Wheaton College Preparatory School in 1900, and received a B.S. degree in agriculture from the University of Illinois in 1904. He returned to the University that same year to work on an M.S. degree, but later in the year was called to the University of Wisconsin as assistant instructor in agricultural engineering. In 1906 he was made chairman of the department, where he remained until 1913 when he was forced to resign due to ill health. From 1913 to 1925 he was associated with the Avery Co. of Peoria, Ill., starting as an agricultural engineer and successively advancing to chief inspector, production manager, purchasing agent, and assistant manager of the Milwaukee plant. When this company closed its operations in 1925, he became a salesman for the next two years for the Convertible Door Co. of Milwaukee. In 1927, he joined J. I. Case Co., Racine, Wis., as a salesman, and in 1928 was transferred to the engineering department as an experimental engineer, where he remained until 1940. He was employed by Harvey Mfg. Co. of Racine, Wis., as an experimental and design engineer from 1940 to 1946. It was at this time, at the age of 73, that he retired from active employment. He wrote many articles for farm papers and magazines and several valuable bulletins on agricultural engineering subjects.

While at the University of Wisconsin, there was an exchange of correspondence between agricultural engineers of several colleges, which resulted in a meeting at the University of Illinois, Urbana, in 1905 of C. A. Ocock, J. B. Davidson, professor, Iowa State University; F. R. Crane, professor, University of Illinois; and William Nye, Purdue University, Lafayette, Ind. They met to discuss the organization of a society of some sort, whereby there could be some general plan laid out for the new work which was then demanding considerable attention in the various colleges and universities. While little was accomplished at this meeting, a subsequent meeting was held at Iowa State University, Ames, at which C. A. Ocock, L. W. Chase, professor, University of Nebraska, Lincoln, and J. B. Davidson were present. Some progress had been made during the year by correspondence with chairmen of some of the many state schools and J. B. Davidson proposed a meeting for 1907 at Madison, Wis. A new agricultural engineering building was to be completed for the first semester of 1907-08; therefore, Mr. Ocock invited all interested in this important field of work to meet with him in 1907 to lay the groundwork for the future. The result of that meeting was the birth of the American Society of Agricultural Engineers.

Charles Ocock was a member of Alpha Zeta Fraternity and a 32nd degree Mason. He is survived by his wife, Pearl K. Ocock, and two sons and one daughter—George K. and Robert C. Ocock, and Mrs. Emily Nielsen.

C. E. Ball

J. H. Wessman

and Land Classification of the Pacific Science Congress, 1953-1958; soils and land classification work in Egypt, Syria, Spain, Morocco, and many southeast Asian countries.

He is a member of many scientific and professional societies including: ASAE membership since 1926; emeritus member of American Society of Agronomy and Soil Science Society of America; member of Western Society of Soil Science; International Society of Soil Science; International Commission on Irrigation and Drainage; American Geophysical Union; Soil Conservation Society of America; Fellow of American Association for the Advancement of Science; Fellow of American Geographical Society; Honorary member of Colombian Society of Agriculture; Chilean Society of Agriculture; Farm Appraisal Institute; National Real Estate Association; Sigma Xi; Honorary professor of University of Chile.

His immediate plans include a trip to Spain to attend the fourth International Congress on Irrigation and Drainage in June, and to return in time for the International Congress of Soil Science meetings in Madison, Wis., in August. After that he plans to act as a land consultant in his spare time.

Charles E. Ball, associate editor of *Farm Journal,* serving as southwestern field editor in Dallas, Texas, was presented the 6th "Asta" award for outstanding agricultural journalism by the American Seed Trade Association during its 77th annual convention, for his editorial efforts during 1959.

John H. Wessman, formerly director of activities for Midwest Feed Manufacturers' Assn. and the Feed Production School, has recently been appointed secretary-treasurer of the Grain Processing Machinery Manufacturers Assn., Kansas City, Mo. He will devote full time to the expanded activities of GPMMA.

Evert Beekmann, ASAE member *(right)* demonstrates his ability to write Korean to an instructor at Yonsei University in Seoul, where he has just completed an 80-hour language course. Beekmann is community industries advisor in the International Cooperation Administration's economic and technical aid mission in Korea. For four years he was with the ICA mission in Pakistan. The mission in Seoul requires all its American employees to study Korean.

Eugene J. Haupt, formerly a senior project engineer, has been promoted to the position of product engineer for New Idea Div., Avco Corp., Coldwater, Ohio. His new duties include responsibility for design work on hay conditioners, hydraulic loaders, shredders and flail type harvesters. He joined the company in 1957.

R. Bruce Curry, upon completing requirements for a Ph.D. degree, has resigned from the staff of the agricultural engineering department at the University of Missouri to accept a position on the staff of the agricultural engineering department, Ohio Agricultural Experiment Station, Ohio State University, Wooster.

G. D. Kite, extension agricultural engineer, Virginia Agricultural Extension Service, Virginia Polytechnic Intstitute, Blacksburg, has been elected for a three-year term to the Executive Committee of the Advisory Committee of the Governor's Highway Safety Committee.

Lloyd M. Miller, district rural and residential sales supervisor for Appalachian Electric Power Co. at Lynchburg, Va., has been promoted to head of the residential heating program for the company's Roanoke Division.

E. B. Hale has joined the extension staff of the agricultural engineering department at Virginia Polytechnic Institute. He will handle the soil and water phase of the agricultural engineering extension program. He is a 1943 graduate of VPI and after Army service worked for the Appalachian Power Co. for four years before joining the University of Tennessee extension staff, where he worked for 10 years in various phases of the agricultural engineering program.

Ralph J. Blair, district residential and rural sales supervisor, Appalachian Electric Power Co., at Pulaski, Va., has been appointed agricultural sales engineer for the company's Bluefield Division.

George E. Marriott recently has been appointed general manager of the Australian branch of John Deere Intercontinental, S.A. He previously was sales manager for John Deere Plow Works in Moline, Ill.

Thomas W. Dunn, recently has resigned his post as vice-president and general sales manager of Carlon Products Corp., Aurora, Ohio. His future plans include work as sales, marketing and distribution consultant to makers of plastic piping and allied products.

Philip W. Manson, professor of agricultural engineering at the University of Minnesota, St. Paul, has been appointed by the Governor of Minnesota to a special committee on water resources.

Evert Beekmann is serving with the International Cooperation Administration in Korea as community industries advisor. Prior to his present assignment, he served with the ICA in Pakistan for four years.

Tappan Collins has been transferred from the Detroit plant of Stran-Steel Corp., where he was quality control manager, to its Terre Haute, Ind., plant where he will serve as manager of the research and development department.

Kenneth E. DeBusk, formerly extension specialist in agriculture, New Jersey Extension Service at Rutgers University, New Brunswick, N. J., has joined the staff of the agricultural engineering department at the University of Tennessee, Knoxville, as an assistant extension agricultural engineer.

E. J. Haupt

R. B. Curry

J. Richard Dye advises that he is now located in Ohio, where he is manager of the Farm Services Div. of Opekasit, Inc. in Hamilton. Previously he was affiliated with Indiana and Michigan Electric Co. in Fairmount, Ind., as rural sales supervisor.

C. J. Hurd advises that he has accepted an overseas mission with the International Cooperation Administration to Tunis, Tunisia, as water resources engineer. He will be working as technical advisor to the Tunisian government on planning of farm and irrigation water supplies and systems. He previously was engaged in the farm electric supply business in Spokane, Wash.

Leon Lyles, formerly agricultural engineer with the Agricultural Research Service, USDA, at Kansas State University, Manhattan, is now located in Weslaco, Texas, as an agricultural engineer with the western branch of the Soil and Water Conservation Research Division of the USDA Agricultural Research Service.

John R. Parks, who previously was an agricultural engineer with the Soil Conservation Service, USDA, Perry, Mo., is now a hydraulic engineer with the U.S. Corps of Engineers, in Fort Worth, Texas.

EVENTS CALENDAR

July 24-30 — *National Farm Safety Week.*

August 7-10 — *Summer Conference, American Institute of Cooperation,* University of California, Berkeley. For additional information write AIC, 744 Jackson Place, N.W., Washington 6, D. C.

August 15-23 — 7th *International Soil Science Congress,* University of Wisconsin, Madison. Additional information may be obtained from Richard Bradfield, president, ISSC, Dept. of Agronomy, Cornell University, Ithaca, N.Y.

August 22-26 — 2nd annual *Western Resources Conference,* University of Colorado, Boulder. Contact Chairman M. E. Garnsey, professor of economics, University of Colorado, Boulder, for details.

August 28-31 — *Soil Conservation Society* 15th Annual Convention, Ontario Agricultural College, Guelph, Canada. For specific information write to: Soil Conservation Convention, Department of Soils, Ontario Agricultural College, Guelph, Canada.

September 6-16 — *Production Engineering Show,* Navy Pier, Chicago, Ill. Will run concurrently with *Machine Tool Exposition.* Clapp & Poliak, Inc., 341 Madison Ave., New York, N. Y., may be contacted for complete information.

September 10-25 — *Lausanne National Fair* ("Comptoir Suisse"), Place of Beaulieu, Switzerland. Information may be obtained from the Consulate General of Switzerland, 75 E. Wacker Dr., Chicago 1, Ill.

(Continued on page 472)

Iowa Section

The Iowa Section held its annual meeting on April 29 at the Hotel Tallcorn in Marshalltown, Iowa. A tour of the Kiowa Corp. preceded the dinner, and the after-dinner program consisted of a movie and discussion about die castings, led by Mr. Furgason, sales engineer of Kiowa Corp. During the business meeting the following officers were elected for 1960-61: L. F. Charity, chairman; R. H. Meier, first vice-chairman (program); W. G. Lovely, second vice-chairman (publicity); B. W. Gustafson, third vice-chairman (membership); R. J. Mullins, secretary-treasurer; R. A. Saul (chairman), P. Jacobson, and H. E. deBuhr, nominating committee.

Florida Section

The Florida Section held its annual meeting on May 6 and 7 at Ormond Beach, with 85 members, wives and guests in attendance. The pace of the meeting program was such that it kept everyone busy, leaving little time to enjoy the wonderful recreation facilities available. Papers concerning all areas of agricultural engineering were presented and covered the following subjects: Long vegetable fibers, plywood building construction, electric irrigation, land clearing equipment, mechanical dewatering of forages, spray equipment, handling citrus fruit, and agricultural developments in the Bahamas.

High light of the meeting was the presentation at the banquet of the first plaques ever awarded by the Section to individuals and organizations making outstanding contributions to Florida agricultural engineering. The recipients were: McGregor Smith, chairman of the board, Florida Power & Light Co., Miami; G. H. W. Schmidt, president, Florida Ford Tractor Co., Jacksonville; Howard Shannon, general manager, Florida Division, Food Machinery & Chemical Corp., Lakeland; and O. R. Hamrick, county agricultural agent, Madison. Also, the following new sections officers were installed: S. O. Dowling, chairman; R. E. Choate, first vice-chairman; R. E. Hellwig, second vice-chairman; D. P. Poulson, third vice-chairman; A. M. Pettis, secretary and editor; and W. H. Parady, treasurer.

North Atlantic Section

The North Atlantic Section will hold its 36th annual meeting August 21-24 at the University of Massachusetts, Amherst. Registration will begin on Sunday afternoon, August 21, followed by a social hour and entertainment in the evening.

A general session will open the meetings on Monday morning at which National President L. W. Hurlbut will speak on agricultural engineering challenges in the sixties. Also addressing this general session will be John Blackmore, agricultural economics, University of Massachusetts, on the subject of dollars and sense in watershed planning. Beginning on Monday afternoon the Farm Structures, Power and Machinery, Soil and Water, and Electric Power and Processing Divisions will hold technical sessions.

"Prefabrication and Design of Farm Structures" will be the Farm Structures Division's theme for the session on Monday afternoon, which will include the following topics: Looking ahead at the farm building market; prefabricated dairy structures; grout surfaced polystyrene panels for farm buildings; relationships of thermal stress to nailing pattern of aluminum roofing; use of computers in designing steel buildings; and realistic loads and stresses for farm buildings. The theme for the Tuesday morning session of the Farm Structures Division will be "Environmental Factors Related to Farm Structures" and papers will be presented on heat losses and gains in experimental farm houses; on fan and pad cooling of greenhouses and farm buildings; on observations on the erection and performance of a colony cage poultry house with prefabricated components; on economic design for optimum winter production of laying hens; on instrumentation for measuring environmental conditions in poultry houses; on response of broilers to combinations of temperature and ventilation environments; and on the effects of floor space allowance on production efficiency and housing costs of laying chickens.

The Monday afternoon session of the Power and Machinery Division will be devoted to the following subjects: Bending and tension strength of forage and energy requirement for impact cutting; the differential lock for tractors; styling farm equipment; evaluation of self-propelled windrower; and new plastic bearing materials, present and predicated uses. "Land Reclamation" will be the theme of the Tuesday morning session of the Power and Machinery Division when the following discussions will be heard: Power requirements and costs of land clearing; economics of land reorganization; construction of dams on tidal rivers; machinery for bogland drainage; and machinery for vertical mulch.

Topics to be covered at the Monday afternoon session of the Soil and Water Division will be: The electrical resistivity method of prospecting for ground water supplies; developing springs and seepage areas for water supply; plastic liners for farm ponds; farm water system design problems; and treatment of domestic water supplies.

The following papers will be presented at the Electric Power and Processing Division session on Monday afternoon: "The Cost to a Farmer for Using Electric Equipment"; "Let's Improve Equipment Servicing"; "The Relationships of Types and

(Continued on page 472)

ASAE MEETINGS CALENDAR

August 21-24—North Atlantic Section, University of Massachusetts, Amherst,

September 9—Washington, D.C. Section.

September 13-15—Farmstead Engineering Conference on Confinement Housing of Livestock, Lincoln Hall Theatre, University of Ilinois, Urbana, Illinois.

October 19-22 — Pacific Northwest Section, Empress Hotel, Victoria, B.C., Canada.

December 5-7—Winter Meeting, Peabody Hotel, Memphis, Tenn.

April 7-8 — Mid-Central Section, St. Joseph, Mo.

April 14-15 — Southwest Section, Grim Hotel, Texarkana, Texas.

June 25-28—Annual Meeting, Iowa State University, Ames, Ia.

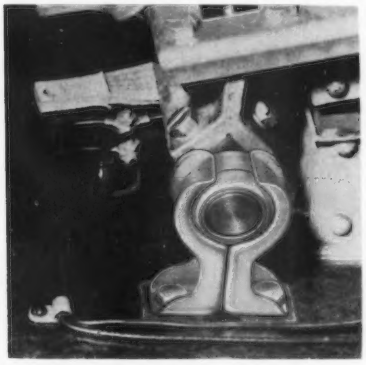
Note: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

R. H. Tweedy *(left)*, retiring chairman of the Iowa Section is shown congratulating the newly elected chairman, L. F. Charity *(center)*, and R. H. Meier *(right)*, first vice-chairman, at the Section's annual meeting on April 29

New officers elected at the annual meeting of the Florida Section on May 6 and 7 for the year 1960-61 are: *(Left to right)* S. E. Dowling, chairman; R. E. Hellwig, second vice-chairman; R. E. Choate, first vice-chairman; A. M. Pettis, secretary; and W. H. Parady, treasurer. One new officer, D. P. Poulson, third vice-chairman, was not present

Pedestal Pillow Block

Triangle Manufacturing Co., Oshkosh, Wis., has developed a new self-aligning pedestal-type pillow block for a manufac-



turer of electrical equipment in an attempt to reduce costs. The stamped support with double-channel cross section provides a sturdy mounting for sleeve-type bearing ball units. The ball-and-socket combination for self alignment was added to speed assembly time by eliminating the need for shimming or machined surfaces. The company specializes in providing bearings and bearing mountings to meet unusual requirements which cannot be satisfied by standard or stock equipment.

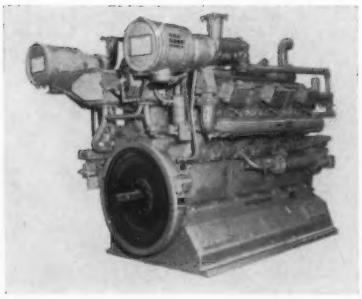
Tank Fabricator Adopts Automatic Gouging Tool

Arcair Company, P.O. Box 431, Lancaster, Ohio, has announced that a new technique involving an automatic process gouging torch, called model Q-3, has been adopted by a steel tank manufacturer. Instead of prebeveling sections of metal for welding, they now fit the square edged parts together, joining them temporarily

with a manual weld joint on the exterior of the tank. The vessel is then welded permanently on the inside with the submerged arc welding process. With the tank mounted on rolls, the automatic gouging torch is then used to remove the temporary outside weld and form a permanent U groove. The torch has its only auxiliary requirements, power from any reputable welding machine and a supply of ordinary compressed air.

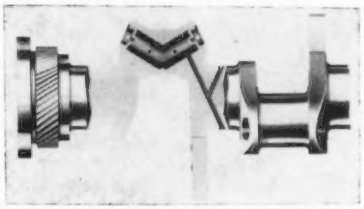
Increases Power for Natural Gas Engines

Caterpillar Tractor Co., Industrial Engine Plant, Peoria, Illinois, reports that horsepower ratings have been increased for the company's line of spark-ignition engines which operate on gaseous fuels. According to the report, turbocharging and aftercooling of these engines result in increased power as much as 90 hp on the G397 (shown) to a continuous rating of 560 hp. Turbo-



charged and aftercooled engines in the G375 and G342 sizes are rated at 380 hp, respectively, for continuous operation.

Heat treatments, special machining and materials employed in crankshafts and bearings are said to be chief items which make it possible for these engines to withstand high bearing loads. Journals are induction hardened and then superfinished by micro honing. All fillets have large radii and are carefully ground and polished. All three models are available with either a 10.5:1 or 7.5:1 compression ratio, depending upon the gaseous fuel to be used. The cutaway

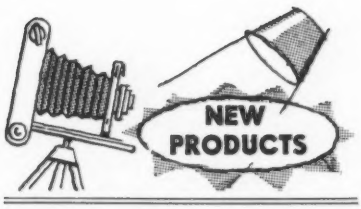


view of the G397 crankshaft (shown) indicates the hardened journal area, the large radii fillets, and the drilled oil passages for providing pressure lubrication for bearings and oil spray cooling of the pistons.

Contact Seals with Bearing Units

Sealmaster Bearing Division of the Stephens-Adamson Mfg. Co., Aurora, Ill., has announced the availability of contact seals

with the "L" series bearing units. The new contact seal is comprised of a three part assembly which presses on the I.D. of the outer race. The inner flinger rides in close running clearance with the O.D. of the inner race. The outer flinger consists of a solid circular ring. These two flingers hold in position a Buna N coated fabric washer

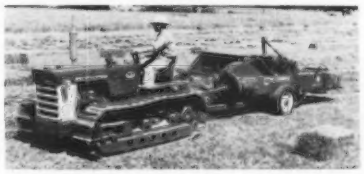


that has an interference fit on the O.D. of the inner race.

The "L" series line of bearing units feature one-piece malleable iron housings and are available in pillow blocks and two or three bolt flange models for flush or recessed mountings.

Small-Sized Crawlers

International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill., has introduced three new farm crawler tractors — one



diesel and two gasoline powered — to meet the needs of farmers who want a small-sized crawler.

The International TD-5 diesel crawler, with 37 flywheel and 28.5 drawbar hp, features a simple direct start engine with precombustion mounted "glow plugs." Other models are the International T-4 gasoline crawler with 34 flywheel and 26.3 drawbar hp and the International T-5 gasoline crawler with 40 flywheel and 30.9 drawbar hp. Engines for both of the gasoline models are the same as those in use with the company's present wheel tractor line.

All three new tractors have 10 forward speeds when equipped with torque amplifier. Standard 5-speed transmission models may be equipped with standard transmission type PTO, while TA models take either standard or constant running PTO.

Models are available with either a 4 or 5-roller track frame; 10, 12 or 14-in. track frame; 10, 12 or 14-in. track shoes; and 38, 48 or 68-in. track gage.

Improves Self-Unloading Forage Box

Gehl Bros. Manufacturing Co., West Bend, Wis., has introduced a new self-unloading forage box featuring a beater clutch for allowing operation of the beaters

independently of feeder aprons. Other features include a higher front end panel to prevent spillage; a faster operating cross conveyor permitting faster unloading; more conveniently located unloading controls; and reinforced front mounting stakes.

(Continued on page 470)

. . . New Products

(Continued from page 469)

Edible Bean Combine

International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill., has introduced an edible bean version of its No. 91

combine. Special features of the bean model are options of a spring tooth cylinder and concave or a rasp bar cylinder unit; a spike-tooth cylinder beater; specially sealed bearings; and a slow speed drive on the feed conveyor and spring tooth cylinder.

The feed conveyor is self adjusting to eliminate "bunching" from uneven windrows and contains a special slip clutch to prevent stone damage. There is also a stone trap in front of the cylinder to prevent damage to the threshing assembly. Extra cleaning is provided by a high speed fan (887-rpm) and by screens in the grain and tailings auger troughs, elevator boots, and unloading auger tube.

New Electric Plant

Kohler Co., Kohler, Wisconsin, has introduced a new 2-kw electric plant powered by Model K241 air-cooled engine (5.6 hp at 1800 rpm). The new plant is lightweight, compact, and is rated at 2-kw output and for intermittent overloads up to 2.5 kw.

Available in models for automatic, remote, or manual starting and for gasoline or combination gas-gasoline operation, the new plant supplies 60-cycle a-c current at 115 or 115-230 volts and is designed for continuous duty or stand-by service.

Twin Engine Tractor

The Oliver Corp., 400 W. Madison St., Chicago 6, Ill. has announced development of a twin engine industrial tractor, called the Twin 880. Two engines (either gasoline or diesel) are used, with each engine driving its respective rear wheel through a torque converter and hydraulic reverse gear providing equal speeds forward and reverse in all gear positions. The rear wheel drives are completely independent of each other. Each engine and drive combination is equipped with an independent speed and direction control level.

Both gasoline and diesel engines have 12 cylinders, with a 3¾ x 4-in. bore and stroke. Total maximum corrected drawbar horsepower is reported at 112.6 for the gasoline model and 109.9 for the diesel. Weight of tractor only is 10,000 lb.

New Utility Tractor Tire

The Firestone Tire & Rubber Co., 1200 Firestone Parkway, Akron 17, Ohio, has developed a new tractor tire for on and off-the-road jobs. The new tire is designed to keep pace with demands of today's utility

and general purpose tractors. It features a new tread design, with short, wide traction bars, that reportedly gives 58 percent more tread contact area over previous design, increases traction for off-the-road jobs, and doubles the tread life on hard surface roads.

Dutch Diesel Announced

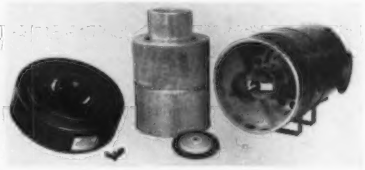
DAF of Holland, Inc., P.O. Box 690, Stamford, Conn., has announced a new diesel engine for truck, industrial and

marine use. The unit, the DS 575, has 6 cylinders and is a turbo-charged, direct-injection type, with toroidal combustion chamber in the piston crown. It has a compression ratio of 16:1, and a total displacement of 351 cu. in. Its bore stroke is 3.96 in. x 4.75 in. Approximate net weight with standard equipment is 1,200 lb.

Producer of the engine is Van Doorne's Automobielfabriek N. V. (DAF) at Eindhoven in the Netherlands.

Two-Stage Dry-Type Air Filter

Purolator Products, Inc., Rahway, N. J., has developed a new two-stage air filter — two filter elements in a single housing, with



each element independently sealed — for both heavy duty automotive and industrial engines. Company engineers report that the two-stage air filter is a genuine two-stage unit because it actually embodies two separate elements, wherein one provides positive protection in the event the other is damaged. The filters were specifically designed to meet the demand for more efficient engine protection where automotive and industrial type equipment is continually operated under abnormally dusty conditions, such as construction, mining, logging, sand, cement, or gravel hauling.

Both the first and second stage elements of the new filter are said to operate independently at 99.8 percent efficiency at all engine speeds. The second stage element's function is to provide continued engine protection in case the first stage, or working element, is damaged. The elements are made from a plastic impregnated cellulose with a new depth type radial pleating. The porosity of the filter media for both elements is the "extra fine" type.

Adapts Diesels for Combines

International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill., has announced that direct-start diesel engines have been adapted for use with its McCormick Nos. 101, 151 and 181 combines.

The UD-236, 6-cylinder, engine that powers the Farmall 460 tractor and said to develop 60 hp, has been adapted for use with the No. 101 combine. The UD-282,

6-cylinder, engine that powers the Farmall 560 tractor and develops 80 hp, has been adapted for use with the Nos. 151 and 181 combines.

Both engines are equipped with "glow plugs" in each pre-combustion chamber. For starting, the operator pushes and holds the glow plug button until each pre-combustion chamber is heated. He then merely presses the starter button and the engine is activated.

New Crawler Tractor Line

The Eimco Corp., P.O. Box 300, Salt Lake City 4, Utah, has announced that more cast steel parts are incorporated into its

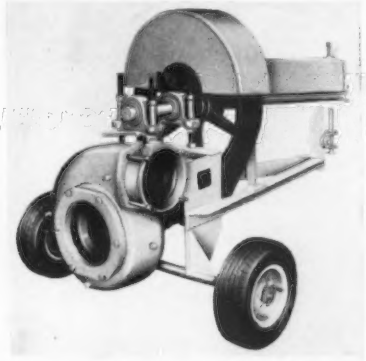
line of 103 tractor series than are found in any other crawler mounted tractor. The manufacturer reports that the concept of unitized "stress flow" construction played an important role in the development of the new tractor series. This, it is said, is a design mechanism by which steel castings are so shaped and so formed that internal stresses and stresses due to applied loads "flow" evenly throughout the structural member.

Other features include air-cooled, mechanical, disc-type brakes that are completely enclosed, and 4-speed "Unidrive" transmission. Coupled with a single-stage torque converter and dual final drives, the transmission features constant mesh gears that never reverse their direction of rotation. The countershaft unit enables the tractor operator to change the direction of rotation of either or both tracks without decreasing power or actuating a master clutch. Power is furnished by a 100-hp GMC Detroit Diesel or Cummins Diesel engine.

The 103 tractor series now in production includes the 103 tractor and bulldozer, the 123 front end loader, the 133 steel mill front end loader, and the 143 log loader.

New Pump Hand Primer

Berkeley Pump Co., 829 Bancroft Way, Berkeley 2, Calif., has developed a new Model 6D pump hand primer featuring



positive displacement type air pump design. The new primer is constructed of aluminum alloy; diaphragm and valves are of molded rubber.

The manufacturer reports that the unit may be installed on any centrifugal pump — motor, engine, or belt drive.

Hay Aerator

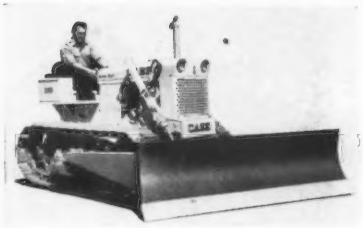
Pollard Manufacturing Co., Foshay Tower, Minneapolis 2, Minn., has announced a new implement, called Hayerator, for aerat-

ing hay. An oscillating tooth said to be simple, compact and positive, and its simplified timing mechanism enables the operator to toss the hay to various heights. The tooth angle is adjustable. The unit is built with a tubular steel framework, PTO driven, and the reel bars are raised and lowered from the tractor seat by means of a hand lever. The swath width can be adjusted from 4 to 7 ft.

New Power Dozers

J. I. Case Co., Racine, Wis., has introduced new utility dozer units with power-angling or power-tilt blades for mounting on 42-hp Model 310 utility crawlers. The new power-angling model allows operator to angle the blade 25 deg left or right without having to stop the tractor. Power to angle the blade is supplied by two double-acting hydraulic cylinders mounted on the A-frame behind the moldboard. Angle of blade is conveniently controlled from the tractor seat by a dash-mounted hydraulic lever.

The power-tilt model is designed especially for road crowning, ditching, digging



out trees, breaking up hard pan and maintaining level grades in rough terrain. Power-tilt blade tilts up to 11 in. to either side while the tractor is in motion. Power is provided by a large hydraulic cylinder mounted on left push arm, and attached to upper rear corner of blade.

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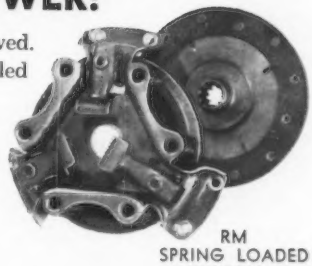

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. . . With ASAE Sections

(Continued from page 468)

Combinations of Poultry Equipment to Poultry Chores"; "Developments in Mechanical Egg Collection and Packaging"; and "Principles for Installing Automatic Livestock Feeding Systems." Bulk milk cooler heats water and lowers costs; measurement of nonelectrical quantities by electrical methods; the 1959 edition of the national electrical code and its effect on farm wiring; oversized service entrances; and fundamentals and applications of mercury lamps are the topics to be included in the Electric Power and Processing Division session on Tuesday morning.

A general session and business meeting on Tuesday afternoon will conclude the meetings, at which time W. M. Carleton will speak on the 1960 USDA Yearbook of Agriculture; Raymond Wyman will talk on visual aids for visibility; and L. L. Boyd will speak on needs and opportunities of graduate study programs. The annual banquet will be held Tuesday evening.

A special program for the entertainment of the ladies and children during the two-day meeting is planned, including tours of the Yankee Atomic Electric Power Plant, Quabbin Reservoir, and New England farms.

Central Illinois Section

The annual spring meeting of the Central Illinois Section was held in Peoria, Ill., on May 12. The meeting opened early in the afternoon at the Russ Nelson Farm west of Peoria, with a demonstration of equipment for moving irrigation pipe by Rainy Sprinkler Sales, Peoria. The second stop was a visit to the Warren Frye Turkey Farm where the group viewed an automatic feeding system in which feed is conveyed through 1-in. pipe to several feeding locations. The afternoon program was completed at the Farm Bureau Building in Peoria with the presentation of papers on equipment for the establishment and maintenance of roadside cover, by D. F. Kampe, and on the analysis of subsurface materials with the refractive seismograph, by C. R. Fahnestock.

Approximately 35 members and guests attended the afternoon program, and 42 members and guests were in attendance at the evening banquet held at the Original Murphys restaurant. One of the featured speakers of the evening was F. B. Lanham, head of the agricultural engineering department, University of Illinois, who explained the facilities at the University and of some of the activities and achievements of the agricultural engineering students, and of the need for more good students in agricultural engineering. The other featured speaker was C. E. Alexander, public relations director, Illinois Farm Supply, who gave an interesting and entertaining pep talk on the responsibility of all of us in keeping pace with the engineering needs of a dynamic agriculture. He challenged the group to tell the real story of agriculture to the public and specifically asked for action in presenting the opportunities in agricultural engineering to high school students. A contribution of $56.00 for the ASAE Motion Picture Fund was collected by holding a drawing for a radio, with Harvey Thomas holding the lucky number. During the business meeting the following officers were elected for 1960-61: K. E. Fuller, chairman; E. F. Randolph, J. H. McCavitt, L. O. Stoeber, vice-chairmen; A. J. Muehling, secretary-treasurer; R. E. Hanson (chairman), W. C. George, H. H. Beaty, nominating committee.

Hawaii Section

The Hawaii Section held a dinner meeting on May 12 at Elliott's Chuck Wagon, with 11 members and three guests in attendance. The program included discussions on the water development and distribution systems, by George Ewart, and on soil conservation service and agricultural engineering, by Lewis Kehne. During the business meeting plans for a proposed two-day field-tour-meeting were discussed. Appointed to serve on the following committees are: H. R. Cerny, general chairman, assisted by L. E. Blomquist, and R. T. Tribble; Transportation, Scheduling and Accommodation Committee — J. K. Wang (chairman), C. B. Holtwick, Kenji Aihara, W. P. Burton, R. Sievers, and R. B. Miller; Publicity and Program Printing Committee —E. P. Morgan (chairman), E. M. Norum, G. A. Roth, L. F. Kehne, W. H. Kahl, S. D. Fox, and W. Kirschbaum. A report was also made by H. R. Cerny on local efforts in organizing a state Engineers Joint Council.

A recent issue of the Hawaii Section News letter revealed some interesting information concerning its membership drive. Two letters were sent to 25 prospective members informing them the purpose and organization of ASAE; also the benefits to be derived by joining. A telephone call was then made to each prospect. The reaction was very encouraging, as out of the 25 persons contacted, eight showed definite interest.

Southeast Section

Blaine F. Parker, secretary-treasurer of the Southeast Section, requests that suggestions for the Section meeting program in Jackson, Miss., be sent to him at the agricultural engineering department, University of Kentucky, Lexington, Ky., by August 1. He also requests that suggestions please include a speaker and a topic.

. . . Events Calendar

(Continued from page 467)

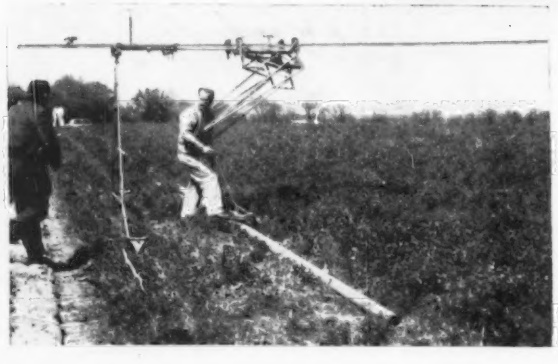
September 12-17 — *Pan American Congress on Engineering Education,* Buenos Aires, Argentina, S. A. Write to Engineers Joint Council, 29 W. 39th St., New York 18, N. Y., for further information.

September 13-15 — *Farmstead Engineering Conference on Confinement Housing of Livestock,* Lincoln Hall Theatre, University of Illinois, Urbana, Ill. For further information write to the American Society of Agricultural Engineers, 420 Main St., St. Joseph, Mich.

September 21-23—7th annual *National Electric Farm Power Conference,* Kentucky Hotel, Louisville, Ky. For information write to: Inter-Industry Farm Electric Utilization Council, Inc., P.O. Box 577, Washington 4, D.C.

September 25-29—68th Annual Convention, *Farm Equipment Institute,* Dallas, Texas. Write to FEI, 608 S. Dearborn St., Chicago 5, Ill., for details.

Officers elected at the Central Illinois Section meeting on May 12 for 1960-61 are *(left to right)*: K. E. Fuller, chairman; E. F. Randolph, vice-chairman; A. J. Muehling, secretary-treasurer; R. E. Hanson, nominating committee; J. H. McCavitt, vice-chairman; and H. H. Beaty, nominating committee. Two new officers not in the picture are: L. O. Stoeber, vice-chairman, and W. C. George, nominating committee



Also, a newly developed machine for moving irrigation pipe sections from one setting to the next by one man *(left)* was demonstrated during the Central Illinois Section meeting. A traveling carrier on a long boom mounted on a propelling unit carries the pipe above the crop including tall corn. Rainy Sprinkler Sales of Peoria conducted the demonstration

MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Heavy Duty Precision Ball Bearings

Split Ballbearing, Division of MPB, Inc., Lebanon, N. H. — Catalog 60, an 8-page, 2-color piece, illustrates and describes the HDR series high-precision radial ball bearings, with load capacities from 19 to 55 percent greater than equivalent size Conrad bearings. Complete engineering information is also given.

V-Belt, Pitch Sheaves and Motor Base Literature

Browning Manufacturing Co., Maysville, Ky. — Offers the following two literature pieces:

Price Sheet No. V-358-A illustrates and describes the 358 grip-belts and the 3, 5, and 8V V-belts. Specifications and list prices are also included

An 8-page, 2-color bulletin, No. SL-101A illustrates and describes line of spring-loaded and manually-controlled type variable pitch sheaves and adjustable motor bases. It also contains specifications, and tables of practical stock drive combinations for conventient selection.

Building Aid Catalog

Timber Engineering Co., 1319 18th St., N.W., Washington 6, D.C. — An 8-page illustrated catalog on timber connectors, framing devices and installation tools provides the architect, engineer and builder with complete specifications and details. Tables of recommended working loads for U-grips, L-grips and clips are included, as well as instructions on the installation of metal bridging.

House Plans

Reynolds Metals Co., Dept. PRD 35, Richmond 18, Va. — A 4-color brochure entitled "Plans for Easy Living with Aluminum Independence Homes" gives floor plans and describes four aluminum homes —The Valley Forge, Yorktown, Concord, and Lexington. Plans are available for 25¢.

Granulated Blast Furnace Slag

U.S. Steel Corp., Slag Products Section, Room 2801, 525 William Penn Pl., Pittsburgh 30, Pa. — A 4-color booklet entitled "USS Granulated Blast Furnace Slag" describes and illustrates how this type of slag is used in the manufacture of cement, construction of highways, agriculture, concrete masonry units, landscaping and general construction.

Tubing Brochure

The Standard Tube Co., 24400 Plymouth Rd., Detroit 39, Mich. — A 4-page technical bulletin on square and rectangular welded steel tubing contains a quick reference weight chart. Also included is a listing of square and rectangular welded tubing tolerances for twist, straightness, cutting length, corner radii, and diagonal dimensions.

Fastener Brochure

Standard Screw Co., 2701 Washington Blvd., Bellwood, Ill. — Dimensional data, photographs, and drawings are included in 2-color brochure on hex and hex screws, carriage bolts, and lag screws.

Wiper-Scraper Seal

Chicago Rawhide Manufacturing Co., Oil Seal Division, 1301 Elston Ave., Chicago 22, Ill. — Four-page, 2-color, illustrated Bulletin SC-100 describes the type SC wiper-

(Continued on page 474)

to designers concerned with salability

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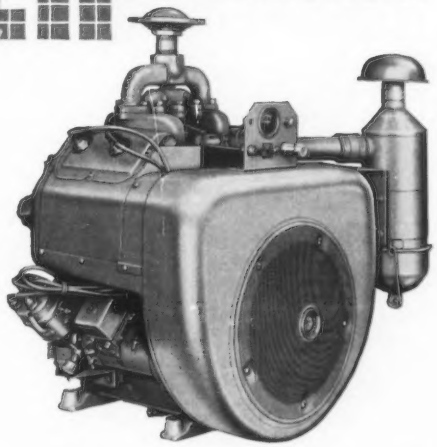

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Gasoline, natural gas, or LPG (for domestic use); and alcohol, kerosene, or No. 1 fuel oil (for export).

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Electric starter-generator system or electric starter only, for all models. Solenoid switches and automatic choke, for remote or automatic starting, also available.

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All 4-cylinder Wisconsins can be equipped with integrally-mounted hydraulic pump.

POWER DRIVES
Centrifugal clutch; over-center clutch; clutch reduction or reduction assembly in a variety of ratios; adaptor to take a spring-loaded clutch; or transmission-torque convertor designs.

DIRECT DRIVES
Special crankshaft extensions are available threaded, tapered, splined, special diameters and lengths, various keys, etc., for close-coupled pumps, generators, and other types of equipment.

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Low-oil-pressure cut-off switch for 2- and 4-cyl. models, and high-temperature safety switch for all models. Air cleaners, pre-cleaners, rotating screens, and removable shroudings for dirty operations.

SPEED CONTROLS
Manual, remote, wire-and-lever, and 2-speed idle-and-load; or provisions for controls of your own design.

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Automotive and spark-arresting mufflers, drive pulleys for flywheel, and rewind starters for ACN and BKN engines.

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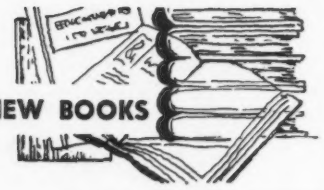

Technical Writing Manual, by Christian K. Arnold. Paper. 5½ x 8½ in. 62 pages. Published by Electronic Periodicals, Inc., 2775 S. Moreland Blvd., Cleveland 20, Ohio. Single copy, $2.50; 5 copies, $2.00 each; 10 copies, $1.75 each.

This handbook of word usage is a compilation of words and phrases commonly misused by engineers and scientists, with concrete examples of correct usage. In reality it is a monograph consisting of selections taken from monthly features entitled "Technical Writing Seminar," and published in *Electronic Digests.*

Freedom to Farm, by Ezra Taft Benson. Cloth. 5¾ x 8½ in. 239 pages. Published by Doubleday & Co., Inc., 575 Madison Ave., New York 22, N. Y. Price, $3.95.

The author, a long-time leader in the field of agriculture, tells in this book what he believes are steps to the solution of the farm problem. Two main things are attempted, according to the author: First, to provide as accurate a summary as possible of the history of our American effort to bolster farm prices and income by federal legislation; second, to give his thoughts about what we should do now and in the future to improve our agricultural picture. This book should be an informative, readable source book for anyone interested in the farm question.

Transactions of the Vth International Congress of Agricultural Engineering, 1958. 17 x 25 cm. 1586 pages. 285 figures. Two volumes. Available at the rate of 850 Belgian Francs (including postage and packing) by transfer to Postal Cheque Account n° 6574 74 of Ve Congres International de Genie Rural, Gembloux, Belgique. For further information, please contact Laret Nestor, Treasurer, Avenue des Combattants, 69, Gembloux, Belgique.

The subjects included in the Transactions are arranged in the following four sections: First Section, the Sciences of soil and water with application in the field of agricultural engineering; Second Section, farm buildings and connected equipment; Third Section, agricultural machinery and rural electrification; and Fourth Section, farm work and processing program.

Farm and Dairy Mechanics, by V. J. Morford. 8½ x 11 in. Paper (spiral bound). 149 pages. Illustrated. Burgess Publishing Co., 426 S. Sixth St., Minneapolis 15, Minn. Price, $3.75.

This laboratory manual, according to the author, is designed to give a broad understanding and varied experience in the areas of farm and dairy mechanics. The courses presented should be judged on the basis of what is taught rather than on what is made in the laboratory. Projects or jobs have been selected that require a minimum amount of materials yet develop basic shop techniques and judgments that may be applied to construction, repair, and maintenance problems common on the farm or in the dairy plant.

Farm Power and Machinery Management — Third Edition, by Donnell Hunt. 8½ x 11 in. Paper (spiral bound). 190 pages. Illustrated. Iowa State University Press, Press Building, Ames, Iowa. Price, $3.50.

This third edition of the farmer's laboratory manual and workbook on the maintenance and care of farm machinery has been completely revised and expanded to keep pace with the rapid changes in the field of farm machinery. It provides a ready reference on machine efficiency, costs, and uses in specific farm situations, for both the farm operator and the student of farm operations. New features of the revised manual include discussions of accessory tractor equipment, traction improvement features of mounted equipment, selecting proper-sized equipment for various farm jobs, and tractor generators and regulators. New commercial farm machinery is also discussed.

Rural Lines — USA. USDA Miscellaneous Publication No. 811. 8 x 10 in. 68 pages. Illustrated. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C. Price, 50 cents.

This is the story of the Rural Electrification Administration's first 25 years — 1935 to 1960, and was written, first, in response to requests for a concise history of the REA-financed electric system program for use in employee and consumer information and educational programs. It should also prove useful to high school and college students, librarians, businessmen, researchers, and those connected with the press, radio, and television who require information about the development of rural electrification.

From Ox Carts to Jets, by Will Oursler. Cloth. 5¾ x 8½ in. vi+346 pages. Illustrated and indexed. Available from Ingersoll Products Div., Borg-Warner Corp., 200 S. Michigan Ave., Chicago 4, Ill. Price $4.95.

In this combined biography of Roy C. Ingersoll and the history of Borg-Warner Corp. is the story of change as seen through the life of this man — the change from primitive to modern ways in many aspects of our lives, such as communication, transportation, production methods, agriculture, and in the personal lives of all people. It is also the story of the men with whom he worked, an American group who blazed their own trails and built great industries. Included are appendices containing detailed historical and statistical material in tabular form, such as the name of the founders and all succeeding presidents of each company, date of founding, products manufactured, acquisitions, changes in corporate names, sales and earnings figures, and other useful data, not only for Borg-Warner but all the major farm machinery producers and the principal automobile companies.

The British Engineers' Association Classified Handbook of Members — 1960 Edition. Cloth. 5½ x 9¾ in. 608 pages. Available from The British Engineers' Association, 32 Victoria St., London, S.W.I., England.

This is the 31st edition of the BEA annual classified handbook of members, their manufactures, trade names and trade marks and is indexed in Portuguese, French, German, and Spanish.

. . . Manufacturers' Literature

(Continued from page 473)

scraper seal, giving its function as protection for packings on reciprocating shafts and hydraulic cylinder rods.

Painting Galvanized Steel

American Iron and Steel Institute, 150 E. 42nd St., New York 17, N. Y. — A 16-page booklet entitled "Painting Galvanized Steel" includes a description of galvanized steel sheets, inhibitive coatings, reasons for painting galvanized sheets, selection of paints, applying the paints, do's when painting galvanized steel sheets, special instructions, and a list of references.

4-Wheel Drive Tractor

Detroit Tractor Ltd., 1221 E. Keating Ave., Muskegon, Mich. — Circular describes and illustrates the Model W4GO62 4-wheel drive tractor, including engine details, and general information. Also listed is detailed information on the attachments — bulldozer, rollbucket, clam, and loader.

Stamping — Forging Booklet

Commercial Shearing and Stamping Co., 1775 Logan Ave., Youngstown 1, Ohio — A 24-page bulletin, No. 900-P5, entitled "How Moving Metal Reduces Parts Cost" describes and illustrates metal components for construction and fabricated products, machinery and equipment, transportation equipment, and missiles and rockets. Also included are examples of the company's many manufacturing facilities — stamping, upset forging rotoforming, shearing, punching, sawing, etc., as well as its line of hydraulic equipment (pumps, valves, motors, and cylinders) and its tunnel and shaft support systems (posts, ribs, liner plates, and ring walers).

Plastics Bulletin

Haas Corp., Mendon, Mich. — A 4-page, 3-color bulletin entitled "Plastics" illustrates and outlines the variety of plastic molding processes available today — such as compression, fiberglass premix, injection, and plunger molding. A summary is given of the preliminary data that a prospective buyer of plastic parts should assemble, to aid his plastic molder in developing, engineering, and producing the parts required. Also included is a list of the plastic molding facilities available at the company plant.

Motor Selector Bulletin

Howell Electric Motors Co., Howell, Mich. — Bulletin L-1661A, an 8-page motor selector, lists in brief a quick reference to the complete motor and generator lines available, including: A complete line of standard motors in a broad range of voltages, speeds, mountings and enclosures; designs for a variety of special applications (cranes, hoists, elevators, machine tools, oil burners, gasoline and water pumps); and flat-type, multi-speed, part-winding, sanitary, torque, reversible, hose reel, and shell type (shaftless and frameless) special motor designs.

Ferrous Forgings Services Brochure

The Union Forging Co., 500 North St., Endicott, N. Y. — "How Union Forging Serves You Better" is a 16-page illustrated brochure in color outlining diversified design, engineering and processing services available in the production, machining, coining and finishing of ferrous forgings for the automotive, aircraft and farm machinery industries. Included are case histories, step-by-step production illustrations and information on improved techniques and cost-cutting engineering approaches in product development.

Liquid Fertilizer Handling Equipment

OPW-Jordan, 6013 Wiehe Rd., Cincinnati 13, Ohio — Four-page Bulletin No. F-31RE is also a condensed catalog describing and illustrating quick couplers, fill tank connections, line strainers, sight glass indicators, swivel joints and nozzles—all specifically designed for use with liquid fertilizers. Composition, safety features, applications, and prices are also listed.

Spray Drying Nozzle

Delavan Manufacturing Co., Grand Ave. and Fourth St., West Des Moines, Iowa — A 2-color catalog insert describes and illustrates spray drying nozzle. Sheets list range of sizes and flow rates available in four different spray angles. Price list is also included.

Thermo-Anemometer Folder

Gelman Instrument Co., 106 N. Main St., Chelsea, Mich. — A folder entitled "Thermo-Anemometer Model GGA2C" describes and illustrates the hot wire anemometer, resistance thermometer, thermo-anemometer, and temperature probes, including the rotating object, liquid-universal, needle, flat, curved surface, and gas probes.

. . . Award Winners

Gordon L. Nelson

(Continued from page 461)

and Sigma Xi, and he is a registered professional engineer.

Dr. Nelson joined the ASAE, in 1946 and has just completed a term as chairman of the Society's Farm Structures Division. In 1957-59 he served as a member of the joint ASAE-ASHRAE Research Advisory Committee on Plant and Animal Husbandry. For one year in 1953-54 he was chairman of the Oklahoma Section of the ASAE. He is presently vice-chairman of the graduate faculty in engineering and physical sciences at Oklahoma State University.

Notwithstanding an exceedingly active professional life, Gordon Nelson is, according to those in the know, a family man and personal friend in the best tradition. In 1942, Gordon married Jeanne Wise, and the six children born to them are Gordon, Jr., Carol, Linda, Janet (deceased), David, and Barbara.

The Nelsons are affiliated with the First Baptist Church of Stillwater, and Gordon teaches a class of university students in the Sunday School.

Among other non-professional activities, Gordon has served both as commanding officer and training officer of the local Naval Reserve surface division, and he is currently training officer of a naval research company.

In the area of recreation, our award recipient would be termed as moderate, especially as regards its demands on his time. He says he takes an annual fishing trip to the Minnesota north woods, spends considerable time in reading, and dabbles in photography. He hunts occasionally, preferably for pheasants; otherwise, rabbits make acceptable targets. Weather permitting, he rides a bicycle to and from his office, not so much, he says, for exercise as for the opportunity it affords of appraising his neighbors' yard work.

From information available concerning the Nelson family and home, the impression is soon gained that it is a delightful example of gracious living. One thing that stands out in particular is the excellent husband and wife teamwork. It is understood that this was specially noted by friends while Gordon was a student officer taking a naval engineering and design course while serving in the Navy. Most of the students, who had had previous engineering training and practical experience in that branch, found the going pretty rough. It was amazing, therefore, to the other students that Gordon Nelson "with only a background in agricultural engineering," as one of them put it, should do so well in the course and receive such a high rating in the class. However, the mystery of high scholastic standing appears to have been revealed to Gordon's fellow students when they came to know his wife, Jeanne. In addition to being the daughter of a college professor and consulting engineer, Jeanne was enrolled in an engineering course and about to receive her degree when she and Gordon were married. Though Gordon's fellow students in the naval engineering course never really established the fact that Jeanne was actually tutoring him and helping him with his homework, they were convinced in their own minds that such was the case.

In commenting on this year's MBMA-ASAE award, a former supervisor of the recipient comments: "Gordon Nelson richly deserves this recognition. He is one of those persons who lets his work speak for him. Gordon is seldom without a friendly smile. His good nature is the first impression one gets when meeting him, and it never wears off." One friend concludes his comment on him in these meaningful words: "Here is a man I would like to work for." It is such comments that reveal the true stature of this 1960 recipient of the MBMA-ASAE award.

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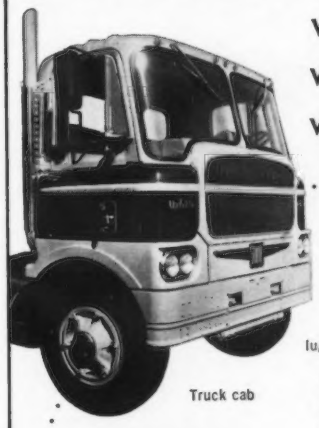

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By C. B. RICHEY, *Tractor and Implement Division, Ford Motor Company, Dearborn, Michigan;* Carl W. Hall, *Michigan State University;* and Paul Jacobson. Ready in October.

This long-awaited handbook for professional agricultural engineers presents, under one cover, the theory and practice involved in the problems of agricultural production which are the concern of the agricultural engineer. The engineering approach is used throughout, but the style is simple and clear enough to allow comprehension by non-engineer readers of all but the most technical portions. Careful editing of contributed material has maintained conciseness, clarity, and the analytical approach throughout.

This book will be a valuable adjunct to all current agricultural engineering texts because of its wealth of new materials in all fields. Of value and interest to students as a reference during study and after graduation, this book will also be of great use to professional farm managers, agricultural extension workers, farm machinery dealers, electric power company field personnel in agricultural areas, and others.

Teaching Science Through Conservation

By MARTHA E. MUNZER, *The Conservation Foundation;* and Paul Brandwein, *Harcourt, Brace and Company.* 470 pages, $7.50

The approach of this book differs from other books in this field in that it emphasizes the interrelationship between conservation and the many branches of science — general science, biology, chemistry, and physics. In a sense, the authors are appealing for greater emphasis on the teaching of conservation in schools and colleges. The book deals selectively with the spectrum of conservation areas: renewable, nonrenewable, inexhaustible, new and to-be-discovered resources.

An annotated bibliography includes selected books, pamphlets, magazines, materials, films and filmstrips.

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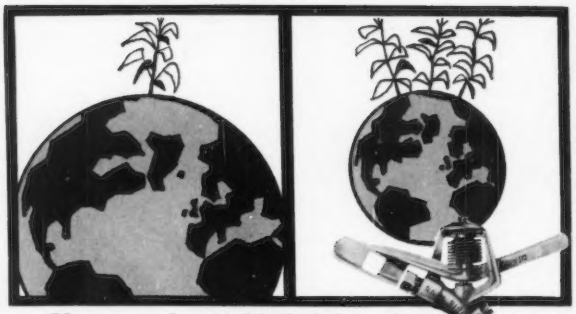

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DESPITE the *presumption* it sets up, mere membership in the American Society of Agricultural Engineers is no *proof* of a man's high rank in technical talent. It does prove that he has met certain minimum requirements and has earned the esteem of colleagues who sponsored his application for membership.

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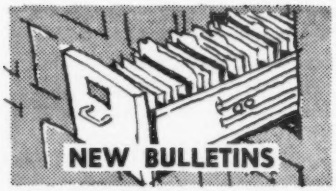


The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

For information on the following guides write to: William L. Cokeley, R.R. 4, Box 126, Olympia, Wash.

Irrigation Guide, Mason County, Wash. U.S. Soil Conservation Service 1959.

Irrigation Guide, Thurston County, Wash. U.S. Soil Conservation Service 1959.

The following may be obtained from the University of Queensland, Department of Agriculture, Brisbane, Queensland, Australia:

Reprint No. 17 — *The Road Ahead for Australian Agriculture,* by L. J. H. Teakle.

Reprint No. 18 — *Fertility Investigations on the Black Earth Wheatlands of the Darling Downs, Queensland; III Mineral Nitrogen in the Soil and Its Relation to the Wheat Crop,* by S. A. Waring and L. J. H. Teakle.

Reprint No. 19 — *A Method of Determining Bulk Density of Soil,* by William E. Fox and D. S. Page-Hanify.

Reprint No. 20 — *An Instrument for the Determination of Soil Volume,* by William E. Fox.

High Resistance to Horizontal Groundwater Flow in Coarse Sediments Due to Faulting, by L. F. Ernst and N. A. de Ridder. Institute for Land and Water Management Research, P.O. Box 35, Wageningen, The Netherlands.

The following may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price, 5 cents.

Plan No. 5870, Portable Shade for Hogs. USDA Miscellaneous Publication No. 819.

Plan No. 5864, Covered Feeder for Cattle. USDA Miscellaneous Publication No. 813.

Agricultural Engineering News, Ideas and Information, Vol. 5, No. 2. April 1960. 1960 Research Issue. Department of Agricultural Engineering, New York State College of Agriculture, Ithaca, N. Y.

New Electrical Equipment for the Farm and Home, by D. W. Works. Farm Electrification Leaflet No. 49. University of Idaho, College of Agriculture, Extension Division, Moscow, Idaho.

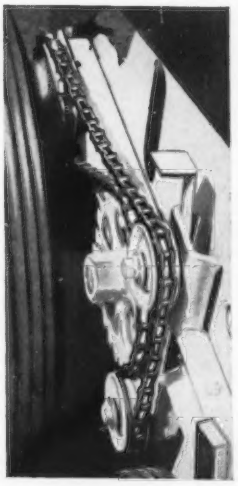
Flood Control in Ohio. Report No. 5, Ohio Water Plan Inventory, plus map. Division of Water, 1562 W. First Ave., Columbus 12, Ohio. Price including map, $1.00. Map separately, 25¢.

The following bulletins are available from Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.: *The Story of Man and Food; The Story of Power Generation; and Research at Allis-Chalmers.*

Gasoline — Facts and Fallacies, by D. W. Bates. Institute of Agriculture, University of Minnesota, St. Paul 1, Minn.

Farm Water Supply, by F. R. Hore. Publication 476. Revised 1960. Ontario Department of Agriculture, Parliament Bldg., Toronto, Ontario, Canada.

out in the field, day after day, year after year



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The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Alcantara, Victor F. — Acting head, farm mechanics dept., Mindanao Agr. College, Musuan, Bukidnon, Philippines

Barnett, William E. — Commodity mgr., Dayton Industrial Products Co., 2001 Janice Ave., Melrose Park, Ill.

Bowie, Andrew J. — Hydraulic engr., SWCRD (ARS), USDA. (Mail) Box 112, Holly Springs, Miss.

Braley, George L. — Field engr., The Oliver Corp. (Mail) R.R. 1, Box 131, Yellow Springs, Ohio

Comer, Ercil G. — Field services dir., South Carolina Electric Co-op., Inc., 808 Knox Abbott Dr., Cayce, S. C.

Davies, William G. — Partner, Ventura Trading Co., P.O. Box 266, Somis, Calif.

de Burgh Codrington, Christopher — Machinery officer, Potato Marketing Board. (Mail) 5 Sydney Place, London, S. W. 7, England

DeCap, Charles L. — Jr. designer, John Deere Harvester Wks. (Mail) 2326 Fourth St. "A", East Moline, Ill.

Dennis, Thomas E. — Agr. engr., SCS, USDA (Mail) 603 Maple St., Crossett, Ark.

Dula-Navarrete, Jose — Sub-dir., Escuela Superior de Agricultura Y Ganaderia Universidad de Sonora. (Mail) Apdo. Postal 624, Hermosillo, Sonora, Mexico

Dunlevy, Walter R. — Sales mgr., Loogootee Clay Products Corp., P.O. Box 295, Loogootee, Ind.

Eddins, William H. — Northstate Orchards. (Mail) R.R. 1, Morven Rd., Wadesboro, N. C.

Feldman, Mottie — Implement testing engr., agr. machinery admin., Government of Sask. (Mail) Suite 1, 3870 Retallack St., Regina, Sask., Canada

Gibb, David O. — Agr. eng. ext. spec., Ont. dept. of agr., ext. branch, Ontario Agr. College. (Mail) 105 Water St., Apt. 303, Guelph, Ont., Canada

Givens, Clarence B. — (With the U.S. Air Force) Box 362, Hill Air Force Base, Utah

Glasscock, Herbert A. — Production mgr., Peterson Mfg. Co. (Mail) 214 Lockport St., Plainfield, Ill.

Griffin, Anselm C. — Acting in charge, div. of agr. eng., Cotton Ginning Res. Laboratory, ARS, USDA, Box 426, Leland, Miss.

Harpel, George T. — (Self-employed) Richards, Mo.

Herndon, John G. — R.R. 1, Dewy Rose, Ga.

Jankowski, Edward M. — Chief engr., Sioux Steel Co., P.O. Box 898, Sioux Falls, S. D.

Koerper, Erhardt C. — Pres., Koerper Engineering Associates, Inc., 7414 W. State St., Milwaukee 13, Wis.

Locke, John J. — Farm operator, Enfield, N. C.

Mangialardi, Gino J., Jr. — Agr. engr., Cotton Ginning Res. Laboratory, USDA, Box 426, Stoneville, Miss.

McCaskill, Oliver L. — Agr. engr., agr. eng. div., Cotton Ginning Res. Laboratory, ARS, USDA, Box 426, Leland, Miss.

McClure, William F. — Res. asst., agr. eng. dept., North Carolina State College, P.O. Box 5906, Raleigh, N. C.

Meile, Carl H. — Chief engr., eng. res., International Harvester Co., 5225 S. Western Blvd., Chicago 9, Ill.

Powell, Joseph A. — R.R. 1, Spring Hope, N. C.

Predmore, Richard F. — Draftsman, product dev., Deere & Co., 301 Third Ave., Moline, Ill.

Simmons, Eugene M., Jr. — R.R. 1, Enfield, N. C.

Walker, Clive H.—Hydraulic-irrigation engr., ARS, USDA. (Mail) 191 S. Third W., Logan, Utah

TRANSFER OF MEMBERSHIP

Campbell, Arthur B. — Agr. eng. ext. spec., ext. branch, Ont. dept. of agr., Ontario Agr. College, Eng. Science Bldg., Guelph, Ont., Canada (Affiliate to Associate Member)

Jutras, Pierre J. — Asst. agr. engr., University of Florida, Citrus Exp. Station. (Mail) Box 702, Lake Alfred, Fla. (Associate Member to Member)

STUDENT MEMBERSHIP TRANSFERS

Alphin, John G. — (North Carolina State College) R.R. 2, Mt. Olive, N. C.

Bollinger, Howard E. — (North Carolina State College) R.R. 2, Box 241, Granite Falls, N. C.

Burt, Eddie C. — (University of Georgia) R.R. 2, Carlton, Ga.

Caldwell, Charlie H. — (Mississippi State University) Batesville, Miss.

Carr, Richard L. — (South Dakota State College) Sioux Falls branch, International Harvester Co., Sioux Falls, S. D.

Chevalier, Willie T. — (Louisiana Polytechnic Institute) Box 946, Glenmora, La.

DeMonbreun, Russell C. — (University of Georgia) 1604 41st St., Columbus, Ga.

Edwards, Donald — Agr. eng. dept., South Dakota State College, Brookings, S. D.

Fluck, Richard C. — (North Carolina State College) R.R. 7, Box 377, Salisbury, N. C.

Fuhrer, Norman H.—(Ohio State University) 1802 W. Granville Rd., Columbus, Ohio

Gilbertson, Gary O. — (North Dakota Agr. College) Heimdal, N. D.

Groven, Allen — (North Dakota Agr. College) Grafton, N. D.

Guill, Marshall F. — (University of Georgia) 516 E. Broad St., Sparta, Ga.

Hall, Edward — (North Dakota Agr. College) Parshall, N. D.

Hammond, Julian C. — (University of Georgia) Bogart, Ga.

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Stratton, Raymond D. — (Kansas State University) Base Eng., 5th Matron Sqdn., A03096218, K. I. Sawyer AFB, Gwinn, Mich.

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Van Dyke, Merline W. — (North Dakota Agr. College) Farm Equip. Res. and Eng. Center, International Harvester Co., 7 S. 600 Co. Line Rd., Hinsdale, Ill.

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Willis, Joe C. — (Mississippi State University) R.R. 1, Box 11, Philadelphia, Miss.

Young, Paul E. — (Ohio State University) New Idea Div., Avco Corp., Coldwater, Ohio

PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail. For further information, see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this bulletin, request form for Personnel Service listing.

Positions Open (1959)—**December**—O-378-974, 384-975, 370-980, 394-981. (1960)—**January**—O-441-985, 452-986. **February** — O-4-601, 11-602, 35-605. **March** — O-57-608, 66-609, 83-610. **April** — O-105-612, 111-613, 114-614, 126-617. **May** — O-169-618, 171-619, 187-620. **June** — O-231-621.

Positions Wanted (1959)—**December** — W-390-59, 388-60. (1960)—**January** — W-411-61, 426-62, 427-63, 433-64. **February** — W-3-1, 10-2, 15-3, 16-4, 17-5, 5-6, 33-8, 37-9, 30-10. **March** — W-46-11, 63-13, 62-14, 69-16, 73-18, 74-19, 76-20, 94-21. **April** — W-99-24, 102-25, 96-26, 110-27, 127-28, 12-29, 117-31, 120-32, 121-33. **May** — W-101-34, 140-35, 129-36, 156-38, 175-39, 119-40, 158-41, 170-42, 103-44. **June** — W-190-45, 191-46, 207-47, 208-48, 199-49, 193-50, 213-51.

NEW POSITIONS OPEN

Chief Dairy Engineer, for key position in charge of dairy engineering department, and responsible for complete design and development program for automatic milkers and other new equipment. Degree in agricultural engineering or similar field desirable. Unusual opportunity for creative engineer with aggressive, established manufacturer located in pleasant Midwestern resort community. Write, giving education, experience, and salary requirement. O-237-622

Agricultural Engineer with mechanical and creative ability for design, development and research in farm power and machinery and other mechanical equipment. Must be able to assume responsibility. A Wisconsin company. O-245-623.

Agricultural engineer for design and development of new tillage implements and specialties, with well-established, financially sound manufacturer. Aggressive management and good sales records. Location Mid-South. BSAE, or equivalent. Field and drawing board experience on tillage tools. Some machine shop or similar experience, and a liking for such work, would be helpful. Farm background essential. Military obligations should be completed. Advancement possibilities unlimited. Salary open, depending on experience and qualifications. O-256-624.

NEW POSITIONS WANTED

Electrical Engineer for engineering liaison, government or customer relations, or personnel development work in power and machinery, electric power and processing, or other fields, with industry or public service, anywhere in U.S.A. Married. No disability. BSEE, 1942. Some graduate study. Farm background. Extensive experience in technical personnel training and administration and public relations. Available on reasonable notice. Salary $950 per month. W-211-52

Agricultural Engineer for design and development in farm structures with manufacturer or trade association, anywhere in U.S.A. Some travel. Married. Age 23. No disability, BSAE, 1960, Virginia Polytechnic Institute. Summer work experience on assembly line, farm, drafting, and general shop work. Available on reasonable notice. Salary open. W-221-53.

Agricultural Engineer for sales promotion or management in power and machinery or construction equipment with manufacturer or distributor. Any location. Prepared to travel and relocate. Single. Age 23. No disability. BSAE, 1959, Pennsylvania State University. Experience since graduation as territory sales supervisor for manufacturer of farm and light construction equipment, involving dealer contacts, service, sales management, credit operations and advertising. Available on two weeks notice. Salary $550-600 per month. W-238-54

Agricultural Engineer for research and development or design in power and machinery. Special interest in automatic materials handling equipment. Capable of handling projects from conception through actual installation. BSAE, 1958, University of Nebraska. Electronics training from DeForest's Training, Inc., 1952, in Chicago. Experience: Production training program with full-line farm machinery company — 1½ yr. Design engineer in R & D department of commercial material handling equipment manufacturer — 2 yr. Age 28. No disability. Salary $7-8,000. W-247-55

Agricultural Engineer for design, development or research in power and machinery with manufacturer, anywhere in U.S.A. Married. Age 30. No disability. BSAE, 1955, Iowa State University. Experience 5 years on design and development of self-propelled combines. Army enlisted service 2 years, before college training. Available in September. Salary open. W-239-56

Hydraulic Engineer for development, research, extension, sales, or service in soil and water, power and machinery or electric power and processing field with federal agency, manufacturer, processor, distributor, consultant, or trade association, anywhere in U.S.A. Married. Age 26. No disability. BS in agriculture, major in agricultural engineering, 1957, Cornell University. Farm background. College and summer work experience in farm operations, laboratories, and as laboratory student instructor. Since graduation hydraulic engineer collecting and computing basic stream flow data. Available on reasonable notice. Salary $6,500. W-252-57

Agricultural Engineer for design, development, or research in power and machinery or farm structures with industry or public service, preferably in eastern or central U.S. location. Married. Age 27. No disability. BSAE, 1955, University of Vermont. Commissioned service as rated pilot, 1956-59. Summer work experience including one summer on farm, 3 summers in civil engineering with state highway department. Management trainee with telephone company. Available August 10. Salary open. W-253-58

Agricultural Engineer interested in irrigation field with public service or private organization anywhere in western U.S. or foreign countries. Married. Age 46. No disability. BS, 1937, Oregon State College, in soils and irrigation. Civil Service employment for 22 years covering 17 western states and 4 foreign countries. Available immediately. Salary $8,500, stateside. W-254-59

Agricultural engineer for design and development in power and machinery with manufacturer. Midwest preferred. Married. Age 33. No disability. BSAE, 1952, Michigan State University. Experience over 9 years with truck manufacturers, from student engineer to project engineer and assistant manager of department. Enlisted service in Navy one year, with advancement to motor machinists mate. Available on reasonable notice. Salary open. W-257-60.

. . . Extending Our Horizons

(Continued from page 457)

I do not want my remarks to detract from the good work of our founders and early pioneers who established our profession. In fact, the achievements of these outstanding early founders and the lasting impressions made by those I have had the privilege to meet or know, have long had my utmost admiration. This has sustained in me a feeling of deep humility as I have tried to serve you this year. Therefore, I feel that the lags which have been pointed out were largely due to the historical manner in which the field of engineering developed separately from the biological and agricultural sciences. Man is still a creature of habit and such customs are difficult to change rapidly. It must have been extremely difficult for our relatively few members during the first half century to introduce the new thought pattern that engineers with specialized agricultural training and background were required to serve the needs of agriculture. But now this is accomplished beyond further doubt of serious question.

Finally, also, we have at last achieved the minimum membership requirements and our ASAE Board of Directors has voted to make the application that will enable us to take our rightful place with the other engineering groups on the Engineers Joint Council. We see many other indications that our profession and our Society are both achieving stature and gaining deserved recognition. The foundations are laid and we are now in position to move firmly forward, to push outward, to extend our horizons far beyond present limits. And, we will have time, for it also says in Ecclesiastes 1:4, "One generation passeth away and another generation cometh; but the earth abideth forever."

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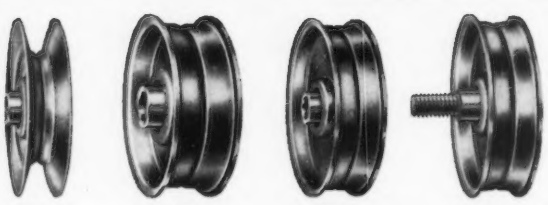
double row ball bearing idler pulleys



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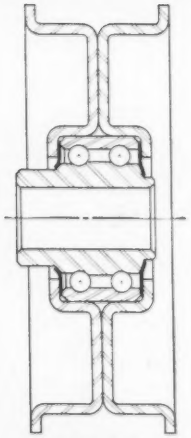

TYPE DRI-2

Series DRI idler pulleys feature double row ball bearings. This unique Split Ballbearing design uses a full complement of balls in each hardened raceway to provide maximum load capacity and long life. The double row bearing is more rigid than single row types, offering more resistance to overturning moments. Pulley wobble is virtually eliminated, with a consequent increase in belt life.

CHECK THESE ADDITIONAL FEATURES:

1. Extended inner ring permits assembly in mounting without loose spacers.
2. Inch dimension bearing bores accommodate standard machine bolts as the pulley mount.
3. Double sealed, and prelubricated with high quality grease for long, maintenance-free service.
4. Heavy gauge steel stampings resist mechanical damage in service.
5. Available in several types with integral shafts. Also available for flat belts, V-belts, chain or cable.

SEND FOR CATALOG SHEET 6838 FOR COMPLETE INFORMATION

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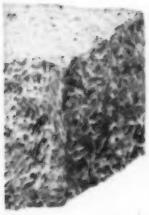
A DIVISION OF MPB, INC.
705 HIGHWAY FOUR, LEBANON, NEW HAMPSHIRE

WITH SHIELDED PTO DRIVE BY

BLOOD BROTHERS!



Again a leading farm implement manufacturer chooses a Blood Brothers Drive Assembly for one of its latest, most advanced new models. It's Oliver's new hay baler – a new capacity leader in its class, with a steady output of 12 tons per hour!

This new Model 62 Baler features an exclusive Roto-Flow Feeder that handles everything from fine, short-stemmed hay to coarse, rank straw in big oversize bunches. And it's a marvel of maneuverability–with a short-coupled "pivot-balanced" Blood Brothers PTO Drive that makes turns shorter and easier.

This drive assembly is typical of the many components that Blood Brothers furnish for both specialized and conventional farm implements. All are the superior products of specialized Rockwell-Standard engineering–designed to meet the manufacturer's needs exactly.

When you consult Rockwell-Standard engineers, you benefit from a wide range of application experience–involving everything from manual steering assemblies . . . to power take-off drives . . . to heavy duty propeller shafts. Let Rockwell-Standard save you time and money – help you achieve higher standards of implement performance.

For complete information, write for bulletin

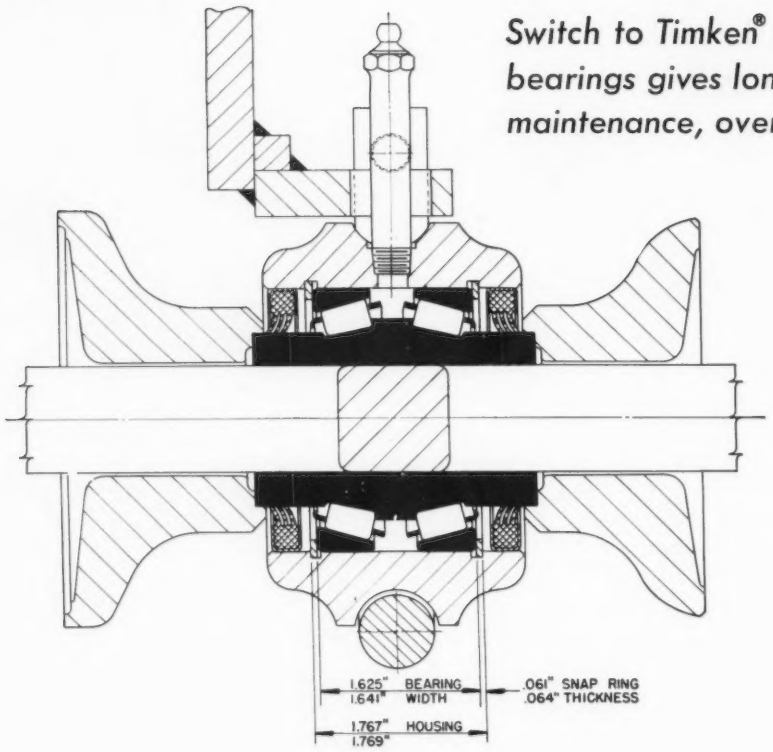
Another Product of...

ROCKWELL-STANDARD
CORPORATION

Universal Joint Division, Allegan, Michigan

Kewanee gets simpler, more economical design in disk hanger for harrow

Switch to Timken® square bore bearings gives longer life, less maintenance, overall economy



BY switching from plain bearings to new Timken® square bore bearings, Kewanee Engineers got greater rigidity, reliability and customer acceptance in their new disk harrow. By using a *snap ring pre-adjusted* bearing mounting, they achieved simplicity and economy in machining and assembly.

While the width tolerances indicated in this assembly appear to provide an excessive spread in bearing adjustment, by following well established principles of statistical quality control, Kewanee was able to obtain highly satisfactory bearing adjustment. And by using a triple-lip seal applied to the hard, smooth ground surface of the bearing cone, they get maximum resistance to the dirt and dust the machine must operate in.

Timken bearings give farm equipment greater rigidity and longer life because their tapered design enables them to take radial and thrust loads in any combination. Full-line contact and rib guided rollers combine to pack more capacity in less space, simplify design, cut costs.

That's why more and more farm equipment manufacturers are switching to Timken bearings. It enables them to give farmers more value, more service for their implement dollar. Timken bearings hold shafts concentric with their housings to make closures more effective, keep dirt out, lubricant in. And because Timken bearings practically eliminate friction they save power and fuel.

With Timken bearings, agricultural engineers find the answer to three big problems: 1) combination loads; 2) dirt; and 3) ease of operation. That's why Timken bearings are your No. 1 value.

Ask your Timken Company Sales Engineer to show you analytically how the fundamental principles of statistical quality control can give you greater economy in your Timken bearing applications. Write: The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ont.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →▭← LOADS OR ANY COMBINATION

The farmer's assurance of better design

TIMKEN BEARING EQUIPPED